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DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

THIRTY-SIXTH ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30
1915

WASHINGTON
GOVERNMENT PRINTING OFFICE
1915

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THIRTY-SIXTH ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

GEORGE OTIS SMITH, *Director*.

The appropriations for the work of the United States Geological Survey for the fiscal year 1914–15 comprised items amounting to $1,620,520. The plan of operations was approved by the Secretary of the Interior, and a detailed statement of the work of the several branches and divisions of the Survey is presented on later pages of this report.

SPECIAL FEATURES.

A LARGER PUBLIC SERVICE.

In the last decade the United States Geological Survey has largely increased its return to the public, both in amount and in variety of service rendered. The statement was made in this report a year ago that never before had the general public been in closer touch with this Survey or made larger use of the results of its scientific investigations. The recognition by citizens generally that the Geological Survey is a bureau of information as well as a field service has gradually placed upon it a large burden of work as well as of responsibility. The amount of correspondence involved in performing this public duty may be indicated by the fact that approximately 50,000 letters of inquiry were handled in the different scientific branches of the Survey last year. The scope of these inquiries is not less noteworthy, for they range from requests for information concerning the geology of every part of the United States or the water supply, both underground and surface, of as widely separated regions as Alaska and Florida, or for engineering data on areas in every State in the Union, to inquiries regarding the natural resources of foreign countries, especially those of Central and South America.

The changes in the world's trade in metals and other mineral products during the last year brought to the Geological Survey a new opportunity for special service. The inquiries concerning possible sources of this or that mineral product began early in August, and the Secretary of the Interior gave to the public an interview outlining the expected developments in the mineral industry. His statement was followed by special press bulletins issued by the Survey on the more important subjects. In September, however, the demand for authoritative information had become so lively that a bulletin—"Our mineral reserves" (Bulletin 599)—was quickly prepared and issued without delay. In this publication the whole subject of the country's ability to meet the emergency demands for minerals was summarized and the Survey offered to serve as an agent in bringing consumer and producer into touch with each other. This new function of acting as "central" to the mineral industry proved popular, a large volume of special correspondence developed, and a gratifying use was made of the Geological Survey's list of mineral producers and of the specific information in the possession of the Federal geologists regarding practically every type of mineral deposit in the country. It is believed that this correspondence has been of material advantage to consumers and producers alike—the users of mineral products who were formerly dependent upon foreign sources of supply and the mine operators who have learned of new markets for their output.

The preparation of this special information to meet a new public demand, together with the continued task of replying to requests for specific information, has resulted in placing fresh emphasis on this phase of the work of the Geological Survey. The rendering of such service is in itself instructive to those charged with the duty, and the Survey staff has acquired a keener realization of the need not only of giving the facts to the public, but also of making those facts intelligible and useful to the citizen who lacks professional training in geology or engineering. Two obligations are thus laid upon the Government scientist—first, that of making his investigations more and more exact in method and more definite in result; second, that of transmitting the product of his investigations in a form to meet the needs of not only his professional associates but of the general public. Most scientists in the public service should aspire to the translation of their own reports into the language of the people.

The Survey as the center of public information concerning the geology of the United States bears an educational obligation to the public. It has so far, in part, neglected its opportunity as well as its duty as an investigative branch of the Government to furnish popular information of an instructive type regarding this most enlightening science. In recognition of this educational responsibility and of the importance of making its work more generally intelligible and useful to the private citizen who has not been geologically educated, several members of the Survey have of late given more attention both to the simplification of the language of the professional publications and to the preparation of reports that are popularly descriptive and instructive, yet also exact and efficient as vehicles for professional discussion or for the announcement of geologic discoveries.

Conforming to this growing conviction, the Survey has printed on the backs of several of its topographic maps nontechnical descriptions of the physical features of the area mapped and of their origin. The evident appreciation by the general public of such explanations of the geologic features as shown by the increased demand for the maps has encouraged the extension of the practice. Accordingly, after the publication of such matter for the map of the Crater Lake National Park, Oregon, the Bright Angel area, in the Grand Canyon of Arizona, has similarly been described, and descriptions for other areas, including the Delaware Water Gap, in Pennsylvania and New Jersey, are now being prepared. This work is a by-product of the geologic mapping and therefore involves comparatively little expense, but it adds greatly to the general interest and educational value of the topographic maps.

Survey geologists have prepared guides covering the points of scenic or unusual geologic interest in the Glacier National Park and in the Mount Rainier National Park, which were published as small brochures for distribution from the office of the Secretary of the Interior, and now the compilation of more elaborate and comprehensive accounts of the geography and the origin of the principal geologic features in several of the national parks has been undertaken for publication as bulletins of the Survey. "The Glacier National Park, a popular guide to its geology and scenery," by M. R. Campbell, has been issued within the year as Bulletin 600. An illustrated guide containing descriptions, with maps, of the geology and of the origin of the striking physical features in the Yosemite Valley of California, with a study of the glaciation, is now being prepared in popular language by F. E. Matthes and F. C. Calkins and will probably be published at an early date as a bulletin. The Mesa Verde National Forest is to be similarly described and illustrated by A. J. Collier, the preparation of whose matter has, however, been necessarily interrupted by work in land classification.

A more ambitious project was undertaken this year. Mindful of the great numbers of educated and intelligent tourists, both American and foreign, who were likely to visit the Pacific coast during the exposition year, and painfully aware of the lack of satisfactory guidebook descriptions, with adequate and accurate maps, covering the physical features of the regions traversed by the greater number of the exposition visitors, the Survey determined to give the public the benefit of a portion of the wealth of geographic and geologic information in its possession, through the publication of guidebooks to the geography, geology, mineral wealth and other natural resources, industries, and history of the regions bordering several of the transcontinental routes. The small amount of money that could be devoted to this project without sacrifice to the public welfare in other lines of Survey work of more importance though of less popular interest made it practicable this year to undertake the preparation of only four such guides, as follows:

The Northern Pacific Route, from St. Paul to Seattle, with a side trip to the Yellowstone National Park (Bulletin 611).

The Overland Route, from Omaha to San Francisco, with a side trip to the Yellowstone National Park (Bulletin 612).

The Santa Fe Route, from Kansas City to Los Angeles, with a side trip to the Grand Canyon of the Colorado (Bulletin 613).

The Shasta Route and Coast Line, from Seattle and Los Angeles to San Francisco (Bulletin 614).

The first of these books, that describing the Overland Route, was issued in June, and the others followed in July, August, and September. These books inform the traveler concerning the great West, its features and its resources, as well as unfold to him in attractive form its fascinating geology. The method adopted is to entertain the traveler by making more interesting what he sees from the car window, to guide his eyes toward the more important or essential things within his field of vision, and then to have much that he sees explained by what is unseen in the swift passage of the train. The magnificent illustrations of the great principles of earth evolution seen along the route are used to teach some of the principles of geology; and fragments of the story of the past are narrated to enable him to interpret the present. As stated in the preface of these volumes—

> The plan of the series is to present authoritative information that may enable the reader to realize adequately the scenic and material resources of the region he is traversing, to comprehend correctly the basis of its development, and above all to appreciate keenly the real value of the country he looks out upon, not as so many square miles of territory represented on the map in a railroad folder by meaningless spaces, but rather as land—real estate, if you please—varying widely in present appearance because differing largely in its history and characterized by even greater variation in values because possessing diversified natural resources. One region may be such as to afford a livelihood for only a pastoral people; another may present opportunity for intensive agriculture; still another may contain hidden stores of mineral wealth that may attract large industrial development; and taken together these varied resources afford the promise of long-continued prosperity for this or that State.
>
> Items of interest in civic development or references to significant epochs in the record of discovery and settlement may be interspersed with explanations of mountain and valley or statements of geologic history. In a broad way, the story of the West is a unit, and every chapter should be told in order to meet fully the needs of the tourist who aims to understand all that he sees. To such a traveler-reader this series of guidebooks is addressed.

Somewhat related to the more distinctly educational reports already described are two bulletins—"The data of geochemistry" (Bulletin 491), by F. W. Clarke, and "Useful minerals of the United

States" (Bulletin 585), compiled by Samuel Sanford and R. W. Stone. A third edition of the former (Bulletin 616) and a revision of the latter, much enlarged by F. C. Schrader, with a glossary showing the composition and character of each mineral (Bulletin 624), are now in course of publication. The editions of these handbooks of general information on broad subjects are rapidly exhausted.

The special efforts of the last year to reach the public with these more popular publications are intended as the beginning of a movement to popularize further the results of scientific investigations. Both the opportunity and the duty of the United States Geological Survey to furnish scientific information in popular form are appreciated.

DEMAND FOR GEOLOGIC WORK.

Especially noteworthy among the features of the year's work is the great increase in the demands made on the Federal geologists for specific investigations of an economic nature. The requests have touched all lines in the geologic province, but most of them ask for the examination of reported discoveries of potash or nitrate salts; for the study of the ore deposits in metal-mining districts, newly discovered or old; or for the investigation of the geologic structure in many regions, with a view to the discovery of areas that may be regarded as structurally favorable for the occurrence of oil or gas pools.

The calls from many States for examinations as to the possibilities of finding oil in untested regions have been nearly as numerous as all others combined, applications for classification of public lands excepted. In this field of applied geology especially the Geological Survey is coming more and more to be regarded as the consulting geologist for the public. Many of the great oil companies, recognizing the paramount value of a knowledge of the geologic structure in the guidance of oil exploration and development, have secured the exclusive services of geologists trained in oil geology. These strong corporations, most of which have lured away from the Survey a number of its best men, are able to organize geologic corps for themselves and to examine geologically great areas of unleased and untested lands in order more certainly to select the sections in which, other things being equal, the prospects for pools are most favorable and the hazards of dry holes the least. But these corporations rarely publish the original information gained by their geologists, and, whether or not the company is able to obtain all the lands it desires, the public is seldom much the wiser for these investigations at private expense.

The appeals to the Survey come mainly from citizens and landowners singly and in groups, from chambers of commerce, and from delegations and communities. The Geological Survey is, by its organic act, forbidden to make and therefore does not make examinations of private lands primarily in behalf of their owners, whether the owners are individuals or corporations. Its examinations are regional in extent, without regard to ownership, and when confined to small areas they are conducted without reference to property lines and with regard only to the geologic problems in hand and to the interests of the community and the Nation in the development of the mineral resources in the vicinity or district. In strict conformity with this principle, the results of all examinations and investigations are withheld until they are printed, either as press notices or as more formal reports, and in these forms they are simultaneously given out to all who ask for them.

Both through its own resources and through the cooperation of State surveys, the Federal Survey greatly extended its examination of oil structure during the year, and the results will be found in its current economic bulletins and in State reports. Yet in this field, as well as in others, the increase in extent and efficiency of the work made possible by the larger funds provided by Congress for this year has been insufficient to warrant attention to any except the most urgent calls on this national bureau for information regarding the geology of the country and for guidance in the discovery and development of its mineral resources. The increase both in the number and in the range of these calls is, in effect, proof of the public's growing appreciation of the value of the Survey work.

A CONTRIBUTION TO PUBLIC HEALTH.

The geologic resource of greatest value to the health of communities is a supply of pure drinking water. It is generally recognized that a number of diseases, prominent among which are typhoid fever and amœbic dysentery—a disease more common in tropical climates but found also in the United States—are contracted through contaminated water or contaminated food. Therefore a supply of pure water will eliminate one of the sources of such infection.

It is highly desirable to obtain supplies of domestic water from sources other than the shallow wells, some of them open, that are found near many houses. The water obtained from deep wells has percolated through sands and other material for so great a distance that its impurities have been removed by filtration, and it possesses a sanitary value that can not well be overestimated, for such water is free from the bacteria causing typhoid fever and the protozoa causing amœbic dysentery, and its use obviates the necessity for shallow wells that may serve as a breeding place for Anopheles, the mosquito to which malarial infection is due.

The United States Geological Survey for a number of years has been prosecuting, largely in cooperation with the State surveys, a systematic study of the ground-water resources of all the Coastal Plain States. Reports have been issued, either by the Federal Survey or by cooperating State geological surveys, for Virginia, North Carolina, Georgia, Florida, Alabama, Mississippi, eastern Tennessee, Kentucky and southern Illinois, southeastern Missouri, southeastern Arkansas and Louisiana, northeastern Texas, the Black and Grand Prairie areas of Texas, and the area underlain by Tertiary formations in Texas south of the latitude of Jefferson and east of Brazos River. The manuscripts of papers on the ground-water resources of Delaware and Maryland, on the ground waters of northeastern Arkansas, and on the ground waters of Lasalle and McMullen counties, Tex., have been completed and will be published during the next fiscal year. Additional studies of the ground waters of Mississippi are in progress and it is hoped that within the next year the manuscript will be transmitted for publication. Comprehensive studies of the ground-water resources of the Coastal Plain of Texas west of Brazos River are approaching completion, and the manuscript of a report will be submitted for publication within a year.

With good health recognized as one of the great national assets, the extent of this study of underground-water resources furnishes a measure of its value to the public. Reports have been published covering 376,000 square miles in the Atlantic and Gulf States, reports on 27,000 square miles are completed though not yet published, field work has been completed on 50,000 square miles, and work is contemplated to cover 16,000 square miles. These areas of nearly half a million square miles include the parts of the United States in which impure water supplies involve the greatest danger. The value of such surveys in conserving public health has already been demonstrated, for it has been noted that wherever an adequate supply of deep-well water has been obtained, typhoid fever, amœbic dysentery, and malaria have abated.

The methods used by geologists in working out the distribution of ground waters are complex, but it is noteworthy that among the more significant criteria used are the fossil remains occurring in the different beds. Each one of the geologic horizons usually has its distinctive fossils, and by an accurate knowledge of these vestiges of organisms the geologist is aided in recognizing particular geologic formations. In this way he may be able to determine by means of the samples taken from the bore the depth to a certain water horizon.

That paleontology, so generally regarded as a purely scientific study, has a great value in the investigation of economic resources may not be generally recognized. In order, however, to understand the conditions controlling the occurrence of any one of three of the most important mineral resources—ground waters, coal, and oil and gas—an accurate knowledge of the succession of the different rock sheets and their geologic structure is essential, and the determination of that order of succession depends upon the study of fossil remains included in these rocks. The value of the work of the paleontologists who have studied the geologic formations in the Coastal Plain area is therefore inestimable. Among the men who have aided in the paleontologic characterization of horizons and thereby assisted in the development of the ground water and oil and gas resources of the Coastal Plain, W. H. Dall, G. D. Harris, and R. T. Hill should be specially mentioned. The excellent work of these scientists has been continued either by themselves or by others who have entered the same fields, and it is hoped that within a few years there may be available biologic characterizations of all the Tertiary and Cretaceous formations of the Coastal Plain. Additional accurate information will assist in the further development of many of the natural resources of the Coastal Plain region.

It is unfortunate that the paleontologists are subjected to increasing overwork, and it is to be regretted that on account of inadequate funds the distinguished Survey specialists engaged in these important studies, which are particularly in demand by the cooperating State surveys, can not be provided with assistance.

It should be added that the science of paleontology has a large educational value, and its popular interest is well illustrated in the western guidebooks, just published. As with geology in general, so in paleontology, the Survey is the central public source of information.

CHANGES IN PERSONNEL.

The death of Henry Gannett, on November 5, 1914, terminated a long and important service. Mr. Gannett was connected with the Survey, with a few interruptions, since 1882 and accomplished much in establishing the methods and fixing the standards of the topographic work in the early days of the organization. He held the title of chief geographer (or chief topographer) in the years 1882 to 1896. His Government work outside of the Survey, chiefly work on the census of the United States, Cuba, Porto Rico, and the Philippines, and his services as chairman of the United States Geographic Board and as geographer of the National Conservation Commission, covered a wide field of geographic investigations and showed large grasp of new problems. He was also president of the National Geographic Society.

Among the important resignations or transfers from the Survey within the fiscal year were those of David T. Day and E. W. Parker. These two men are to be credited with the development of the division of mineral resources, a service that is unique among the statistical organizations of the world. Dr. Day, after a service of nearly 30 years, was transferred August 31, 1914, to the Bureau of Mines, where, as consulting chemist, he will continue his investigation of the special problems connected with the technology of petroleum, devoting part of his time to this Government work. Mr. Parker, who served in various positions in the Survey since 1891 and who has been in charge of the collection of statistics of the mineral resources of the United States since 1908, resigned June 30, 1915, to accept an important position with the anthracite-coal interests. Mr. Parker's resignation necessitated several changes in the division of mineral resources—the appointment of Hiram D. McCaskey as geologist in charge, of E. F. Burchard as geologist in charge of the section of nonmetallic resources, and of C. E. Lesher, associate geologist, to take charge of the statistics of coal. The number of men designated to take up the work relinquished by Mr. Parker is perhaps the strongest indication of the amount and importance of that work, which he so long successfully carried on.

Mr. E. C. Barnard, geographer, resigned May 2, 1915, after a service of more than 30 years, to accept the position of expert commissioner on the part of the United States in the International Boundary Commissions (Canada). Since 1910 Mr. Barnard's connection with the Geological Survey has been only nominal, by reason of his detail to the State Department in connection with the surveys of the international boundary.

Other changes in the organization were the appointment, in January, of Philip S. Smith as administrative geologist and, in the absence of the Director, Acting Director, and the appointment, in February, of Guy E. Mitchell as chief of the executive division. Mr. Mitchell was succeeded by T. P. O'Hara as private secretary to the Director.

EXHIBIT AT PANAMA-PACIFIC EXPOSITION.

With a small allotment from the congressional appropriation for the Government exhibit at the Panama-Pacific Exposition, San Francisco, the Survey has made a creditable and instructive exhibit, including scenarios showing many of the kinds of work done by the Survey in exploring and investigating the resources of the country; an exhibit of the per capita production of minerals of the United States; an exhibit of the use of many of the minerals in the rough and in the manufactured form; and specimens, maps, pictures, and instruments illustrative of various subjects studied or used by the Survey. Ralph W. Stone, geologist, was detailed to have charge of the exhibit and to give illustrated lectures daily describing the work of the Survey. The Survey has been awarded one grand prize, three medals of honor, three gold medals, two silver medals, and one bronze medal. Silver medals for collaboration were also awarded to the following Survey members: George H. Ashley, A. H. Brooks, J. C. Hoyt, S. J. Kübel, R. B. Marshall, and Edward W. Parker.

SCOPE OF THE WORK.

In the following pages of this administrative report the activities of each branch of the Survey are set forth in detail; the following paragraph is a brief summary of the whole. Geologic investigations were made in 47 States and Alaska; topographic surveys were made in 30 States, Alaska and Hawaii, and stream measurements were made in 41 States and Hawaii. The total area covered by the geologists in reconnaissance and detailed surveys was more than 76,000 square miles and the area topographically mapped by the topographers was more than 35,000 square miles. The land-classification work of the Geological Survey last year resulted in the classification of about 36,000 square miles in the public-land States. In the collection of statistics of mineral production the Geological Survey cooperated with the State geologists of 16 States and carried on correspondence with 90,000 producers.

WORK OF THE YEAR.

PUBLICATIONS.

The work of the Geological Survey is reflected chiefly in the publication and distribution of its printed reports and maps. The publications of the year consisted of 1 annual report, 1 monograph, 5 professional papers, 10 separate chapters from 2 professional papers, 35 bulletins, 30 separate chapters from 5 bulletins, 33 water-supply papers, 18 separate chapters from 4 water-supply papers, 1 annual report on mineral resources for 1913 (published also in 62 advance chapters, 15 delivered in 1913–14 and 47 in 1914–15), 5 advance chapters from the annual report on mineral resources for 1914, 3 geologic folios, 2 lists of publications, 1 list of topographic maps and folios, pamphlets entitled "Topographic instructions of the United States Geological Survey, 1915," and "Service bulletin, 1914," leaflets entitled "Nature and uses of topographic maps," "The production of copper in 1914," and "The production of spelter in 1914," 3 circulars concerning geologic folios, 22 index-map circulars, 55 press bulletins, and 10 monthly lists of new publications. The total number of pages in these publications was 23,574, a notable increase from the preceding year and a larger number than in any other year of the Survey's history. The publications of the year 1913–14 comprised 16,631 pages.

Brief notes on the publications of the year are given below.

THIRTY-FIFTH ANNUAL REPORT OF THE DIRECTOR of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1914. 1914. 163 pages, 2 plates.

A detailed account of the work of the Geological Survey during the fiscal year 1914, with a statement of the total appropriation made by Congress for the Survey and the allotments for each kind of work. Under the heading "Special features" is a brief discussion of the province of a Federal Survey. The report also includes abstracts of the publications of the year and maps of the United States showing areas covered by topographic and geologic surveys.

MONOGRAPH 53. The Pleistocene of Indiana and Michigan and the history of the Great Lakes, by Frank Leverett and F. B. Taylor. 1915. 529 pages, 32 plates, 15 text figures. Price $1.50.

Describes in detail the glacial features and the great glacial lakes of a district which includes a considerable part of Indiana and all of the southern peninsula of Michigan. The question of a pre-Illinoian drift in southern Indiana is briefly treated, but the Wisconsin drift, the concealed portions of the earlier drift sheets that underlie it, and the somewhat intricate lake history associated with and following the retreat of the ice are the main subjects of discussion. The monograph is profusely illustrated with maps showing the topography and geology of the area discussed, glacial lakes and eskers, ancient lake beaches, morainic systems, profiles of warped water planes, and river distributaries. It is closely related to Monographs 38 and 41, which treat of glacial geology in districts directly adjoining that discussed in the present report.

PROFESSIONAL PAPER 85. Shorter contributions to general geology, 1913. David White, chief geologist. 1914. 99 pages, 14 plates, 7 text figures.

The first volume of a new series to be published annually by the Geological Survey under the title "Shorter contributions to general geology." In advance of the printing of the full volume, separates, each including one or more papers, are issued to the number of 10 or 12 a year as the manuscript and illustrations are ready without waiting until the material for the full volume is in hand or even promised. These separates are paged continuously, so that the volume is simply a consolidation of the separates, without change of pagination. The papers included in these "Shorter contributions to general geology" may relate to any phase of geology, provided it possesses general interest—petrology, paleontology, stratigraphy, glaciology, structural geology, etc. This volume is intended not as a catch-all for current odds and ends, but as a dignified collection of scientific contributions, each suitable in importance of subject, value of results, and quality of treatment for separate publication as a bulletin or professional paper if it were of sufficient length.

Professional Paper 85 contains the following contributions:

The origin of colemanite deposits, by H. S. Gale.

The mud lumps at the mouths of the Mississippi, by E. W. Shaw.

Interpretation of anomalies of gravity, by G. K. Gilbert.

The Jurassic flora of Cape Lisburne, Alaska, by F. H. Knowlton.

Resins in Paleozoic plants and in coals of high rank, by David White.

PROFESSIONAL PAPER 86. The transportation of débris by running water, by G. K. Gilbert, based on experiments made with the assistance of E. C. Murphy. 1914. 263 pages, 3 plates, 89 text figures.

The finer débris transported by a stream is borne in suspension; the coarser is swept along the channel bed. The suspended load is readily sampled and estimated, and much is known as to its quantity. The bed load is inaccessible, and we are without definite information as to its amount. The primary purpose of the investigation of which Professional Paper 86 is the outcome was to learn the laws which control the movement of the bed load, and especially to determine how the quantity of load is related to the stream's slope and discharge, and to the degree of comminution of the débris. The paper contains the record and discussion of a series of experiments made in a specially equipped laboratory at the University of California, Berkeley, in the years 1907–1909.

PROFESSIONAL PAPER 87. Geology and ore deposits of Copper Mountain and Kasaan Peninsula, Alaska, by C. W. Wright. 1915. 110 pages, 22 plates, 11 text figures.

A detailed description of the geology of Kasaan Peninsula and Copper Mountain, the two most important copper-bearing areas in southeastern Alaska, prefaced by a general account of the geology of the Ketchikan district, within which these areas lie. The mining development is only briefly discussed, because it is not of permanent interest and is fully treated in the Survey's annual bulletins showing the progress of investigations of mineral resources in Alaska. The genesis and occurrence of the copper ores are discussed, and special attention is paid to contact deposits, which are well exemplified in this region. The illustrations include a geologic map of the Ketchikan district, topographic and geologic maps of Copper Mountain and Kasaan Peninsula, plans and sections of mines, and halftone views of rocks and minerals from the areas discussed.

PROFESSIONAL PAPER 88. Lavas of Hawaii and their relations, by Whitman Cross. 1915. 97 pages, 4 plates.

Describes in detail the petrography of the Hawaiian Archipelago, treating each of the larger islands individually. It is an accepted generalization concerning the Hawaiian Islands that they have been built up by a long-continued series of volcanic eruptions beginning at a point far west of the principal islands of to-day. They represent, therefore, the higher summits of a chain of volcanic mountains, mainly submarine, rising from an ocean floor more than 20,000 feet below the surface of the sea and extending for about 1,800 miles in a general north-northwesterly direction. They appear to form a simple petrographic province whose igneous rocks are clearly consanguineous. The paper also discusses the mineral, chemical, and normative composition of the Hawaiian lavas, as well as their distribution and association, and the theoretical bearings of the data presented. A map of the islands, photomicrographs of the rocks, a diagram illustrating variation in normative composition of the lavas, and a table of normative ratios and symbols, accompany the report.

PROFESSIONAL PAPER 90. Shorter contributions to general geology, 1914. David White, chief geologist. 1915. 199 pages, 21 plates, 20 text figures.

A consolidation of 12 short papers which were first issued as parts A to L, inclusive, forming the second annual volume bearing this title. The corresponding volume for 1913 was Professional Paper 85.

Professional Paper 90 contains the following contributions:

Geology of the pitchblende ores of Colorado, by E. S. Bastin.

Erosion and sedimentation in Chesapeake Bay around the mouth of Choptank River, by J. F. Hunter.

Dike rocks of the Apishapa quadrangle, Colorado, by Whitman Cross.

The composition of crinoid skeletons, by F. W. Clarke and W. C. Wheeler.

Contributions to the stratigraphy of southwestern Colorado, by Whitman Cross and E. S. Larsen.

A reconnaissance in the Canyon Range, west-central Utah, by G. F. Loughlin.

The Montana group of northwestern Montana, by Eugene Stebinger.

A deep well at Charleston, S. C., by L. W. Stephenson, with a report on the mineralogy of the water by Chase Palmer.

The stratigraphy of the Montana group, with special reference to the position and age of the Judith River formation in north-central Montana, by C. F. Bowen.

The Cretaceous-Eocene contact in the Atlantic and Gulf Coastal Plain, by L. W. Stephenson.

The history of a portion of Yampa River, Colorado, and its possible bearing on that of Green River, by E. T. Hancock.

The inorganic constituents of echinoderms, by F. W. Clarke and W. C. Wheeler.

PROFESSIONAL PAPER 95–A. Composition of muds from Columbus Marsh, Nevada, by W. B. Hicks. 1915. pp. 1–11, fig. 1.

A part of Professional Paper 95, "Shorter contributions to general geology, 1915." Professional Paper 95–A is a further report on the investigation of the dry lake of Columbus Marsh, situated on or near the line between Esmeralda and Mineral counties, Nev. The investigation of this lake, begun in 1912, had for its economic motive the discovery of potash. Results of the work done in 1912 are given in Bulletin 540–N. Professional Paper 95–A tells of the work done in 1913, which included the drilling of one shallow well and the collection of a set of surface samples of muds from the marsh. After considering all the facts at hand, the author expresses his belief that large amounts of potash have been absorbed from surrounding or percolating solutions and are held in loosely combined form by the muds of Columbus Marsh and perhaps by the muds of the desert basins in general, while the other salts, being less completely absorbed, have been gradually concentrated through evaporation. This theory explains the presence of the natural brines and salt incrustations with low potash content now found in the desert regions of the United States.

PROFESSIONAL PAPER 95–B. Eocene glacial deposits in southwestern Colorado, by W. W. Atwood. 1915. pp. 13–26, Pls. I–IV, figs. 2–11.

Professional Paper 95–B describes briefly the geology of the Montrose quadrangle, near Ridgway, Colo., at the base of the San Juan Mountains. This locality is of especial interest because one series of its exposed rocks includes a section of glacial till that is overlain by formations of Tertiary age. These exposures were found in September, 1913, in the same region where three distinct stages of Pleistocene glaciation among the mountains were demonstrated in 1912. The illustrations include a map of the area discussed, showing distribution of Eocene and Pleistocene glacial deposits, and geologic sections at several localities near Ridgway, Colo.

BULLETIN 541. Contributions to economic geology (short papers and preliminary reports), 1912, Part II, Mineral fuels—M. R. Campbell, geologist in charge. 1914. 532 pages, 29 plates, 17 text figures.

This bulletin includes 26 brief reports of two classes—(1) short papers giving comparatively detailed descriptions of occurrences that have economic interest but are not of sufficient importance to warrant a more extended description; (2) preliminary reports on economic investigations, the results of which are to be published later in more detailed form. These papers are such only as have a direct economic bearing, all topics of purely scientific interest being excluded. They have been grouped according to subjects or general regions, and each group has been issued as an advance chapter as soon as it was ready. A complete list of the papers included in the volume follows:

Oil and gas in the northern part of the Cadiz quadrangle, Ohio, by D. D. Condit.

Gas from mud lumps at the mouths of the Mississippi, by E. W. Shaw.

Structure of the Fort Smith-Poteau gas field, Arkansas-Oklahoma, by C. D. Smith.

The Glenn oil and gas pool and vicinity, Oklahoma, by C. D. Smith.

The Douglas oil and gas field, Converse County, Wyo., by V. H. Barnett.

The Shoshone River section, Wyoming, by D. F. Hewett.

Oil and gas near Green River, Grand County, Utah, by C. T. Lupton.

Petroleum near Dayton, N. Mex., by G. B. Richardson.

Reconnaissance of the Barstow-Kramer region, California, by R. W. Pack.

Rhode Island anthracite, by G. H. Ashley.

Coking coal in Powell Mountain, Scott County, Va., by M. R. Campbell.

The coal resources and general geology of the Pound quadrangle of Virginia and Kentucky, by Charles Butts.

The coal resources of a part of northeastern Missouri, by F. C. Greene.

The Cannonball River lignite field, Morton, Adams, and Hettinger counties, N. Dak., by E. R. Lloyd.

Lignite in the vicinity of Plentywood and Scobey, Sheridan County, Mont., by C. M. Bauer.

Geology and coal resources of the area southwest of Custer, Yellowstone, and Bighorn counties, Mont., by G. S. Rogers.

Coal discovered in a reconnaissance survey between Musselshell and Judith, Mont., by C. F. Bowen.

The Cleveland coal field, Blaine County, Mont., by C. F. Bowen.

The Big Sandy coal field, Chouteau County, Mont., by C. F. Bowen.

The Horseshoe Creek district of the Teton Basin coal field, Fremont County, Idaho, by E. G. Woodruff.

The Glacier coal field, Whatcom County, Wash., by E. G. Woodruff.

The Eden Ridge coal field, Coos County, Oreg., by C. E. Lesher.

Geology and coal resources of the Sierra Blanca coal field, Lincoln and Otero counties, N. Mex., by C. H. Wegemann.

Coal near Thompson, Grand County, Utah, by F. R. Clark.

Coal near Wales, Sanpete County, Utah, by F. R. Clark.

Analyses of coal samples from various fields in the United States, by M. R. Campbell.

BULLETIN 544. Fauna of the Wewoka formation of Oklahoma, by G. H. Girty. 1915. 353 pages, 35 plates.

Describes the fauna of the Wewoka formation, which is typically exposed in the Coalgate and Wewoka quadrangles, in Atoka, Coal, Hughes, Okfuskee, Okmulgee, Pittsburg, Pontotoc, and Seminole counties, Okla. This formation occupies a part of the Carboniferous area of Oklahoma, which is especially interesting because its rocks were laid down under physical conditions so much at variance with those of the Carboniferous areas farther north and east that both its sediments and its faunas show marked differences from those of the other areas. The fossils of the Wewoka formation are in an excellent state of preservation and offer an opportunity for careful generic and specific studies which may serve as a starting point for work in less satisfactory material. The illustrations show specimens of the fossils described in the report.

BULLETIN 548. Electric activity in ore deposits, by R. C. Wells. 1914. 78 pages, 7 text figures.

A contribution to the study of ore deposits, showing that contact with solutions, as well as some other conditions, may impart electric energy to certain metalliferous minerals, thus transforming them into conductors of electric currents in ore deposits. Under certain conditions the valuable metals may be deposited from solutions by electrolytic action and thereafter be protected from redissolving by contact with any of the more oxidizable ores. Although the results thus far obtained afford no adequate basis for any method of electric prospecting, this bulletin possesses value in the broader investigation of ores, for even feeble currents may exert a directional influence on ore deposition, and chemical conditions, even at a distance, may be a factor in determining mineral association. The illustrations consist of diagrams showing apparatus and methods used in studying currents produced by combinations of solutions and minerals.

BULLETIN 549. The Shinumo quadrangle, Grand Canyon district, Arizona, by L. F. Noble. 1914. 100 pages, 18 plates, 1 text figure.

Ever since Powell's daring boat trip down the Colorado in 1869 geologists have known that the walls of the Grand Canyon display one of the most remarkable and instructive geologic sections in the world. Bulletin 549 treats of the geology of part of this district—the Shinumo quadrangle, covering about 270 square miles in Coconino County, northern Arizona. Although the book contains considerable lithologic and stratigraphic material that will scarcely interest those who are not geologists, the author has very properly remembered that the people as a whole have unusual claims to consideration in any publication dealing with the Grand Canyon, and has skillfully supplied as a setting to his more strictly scientific work much vivid description and lucid explanation, which will help all those who take more than a transient and superficial interest in what they see to understand one of the most impressive and significant of the inanimate works of nature.

The map which accompanies this bulletin represents the first geologic mapping done in the canyon that attains the standard of accuracy and detail set for the Geologic Atlas of the United States.

Bulletin 550. The ore deposits of northeastern Washington, by Howland Bancroft including a section on the Republic mining district by Waldemar Lindgren and Howland Bancroft. 1914. 215 pages, 19 plates, 26 text figures.

Describes the geology of an area of about 6,000 square miles in Stevens and Ferry counties, northeastern Washington, giving detailed information as to its mining districts and ore deposits—chiefly lead, zinc, and copper. States that the general conditions for mining are particularly favorable and discusses briefly the methods and costs of mining, treatment of the ores, and means of transportation. The illustrations include plans and sketch maps of some of the mines and halftone plates showing geologic conditions.

Bulletin 559. Results of spirit leveling in Michigan, 1911 and 1913—R. B. Marshall, chief geographer. 1914. 79 pages, 1 plate.

Bulletin 560. Results of spirit leveling in Minnesota, 1897 to 1914, inclusive, R. B. Marshall, chief geographer. 1915. 190 pages, 1 plate.

Bulletin 561. Results of spirit leveling in Hawaii, 1910 to 1913, inclusive. R. B. Marshall, chief geographer. 1914. 42 pages, 1 plate.

Bulletin 562. Results of spirit leveling in Virginia, 1900 to 1913, inclusive. R. B. Marshall, chief geographer. 1914. 68 pages, 1 plate.

Bulletin 563. Results of spirit leveling in Maryland, 1896 to 1911, inclusive. R. B. Marshall, chief geographer. 1914. 80 pages, 1 plate.

Bulletin 566. Results of spirit leveling in Utah, 1897 to 1914, inclusive. R. B. Marshall, chief geographer. 1915. 77 pages, 1 plate.

Bulletin 567. Results of spirit leveling in Idaho, 1896 to 1914, inclusive. R. B. Marshall, chief geographer. 1915. 130 pages, 1 plate.

Bulletin 569. Results of spirit leveling in Iowa, 1896 to 1913, inclusive. R. B. Marshall, chief geographer. 1915. 126 pages, 1 plate.

Bulletin 570. Results of spirit leveling in Wisconsin, 1897 to 1914, inclusive. R. B. Marshall, chief geographer. 1914. 86 pages, 1 plate.

Bulletin 572. Results of spirit leveling in Nebraska, 1896 to 1913, inclusive. R. B. Marshall, chief geographer. 1914. 57 pages, 1 plate.

Reports on precise and primary leveling in the States mentioned, showing the exact altitude of a great number of places. The work in Michigan, Hawaii, and Maryland, and part of that in Minnesota, Virginia, Iowa, and Nebraska was done in cooperation with the States. Each bulletin contains a halftone plate showing Geological Survey designs for bench marks.

Bulletin 574. Mining districts of the Dillon quadrangle, Montana, and adjacent areas, by A. N. Winchell. 1914. 191 pages, 8 plates, 16 text figures.

A sketch of the geology of the Dillon quadrangle, which covers about 3,200 square miles in southwestern Montana, and detailed descriptions of its mining districts. The illustrations consist of geologic sketch maps of many of the districts and halftone plates showing geologic conditions.

BULLETIN 576. Geology of the Hanagita-Bremner region, Alaska, by F. H. Moffit. 1914. 56 pages, 6 plates, 6 text figures.

This bulletin presents information about a region that was very little known prior to 1911. Although the author's survey was of a reconnaissance character it was sufficiently detailed to outline the geography, general geology, and geologic history of the region and to obtain information about the occurrence and distribution of the gold and copper deposits. The Hanagita-Bremner region includes some mineral deposits which, though almost undeveloped, give promise of becoming commercially valuable, now that they have been made comparatively accessible by the railroad recently completed up the Copper River valley. The illustrations include topographic and geologic reconnaissance maps, a map showing the distribution of timber, and diagrams illustrating some of the methods of formation of canyons and other stream channels.

BULLETIN 577. Geology of the phosphate deposits northeast of Georgetown, Idaho, by R. W. Richards and G. R. Mansfield. 1914. 76 pages, 14 plates, 3 text figures.

This report discusses briefly the geography and geology of an area in Bear Lake and Bannock counties, southeastern Idaho, and a part of Georgetown Canyon. Detailed descriptions, by townships, of the phosphate deposits are given, and the book contains geologic maps and sections of many of the phosphate-bearing districts. The type of geologic survey represented in this work is a development of the constantly increasing requirement for detail. The delineation of phosphate outcrops in areas beyond the properties that have been located and the estimation of the depth, tonnage, and quality of the different beds furnish part of the data.

BULLETIN 578. The Iditarod-Ruby region, Alaska, by H. M. Eakin. 1914. 45 pages, 6 plates, 1 text figure.

Describes an area in west-central Alaska between the mining settlements on Iditarod River and those on the Yukon at Ruby, visited by the author in the summer of 1913. This volume is the third report based on work inspired by the discovery of gold in the Innoko district in 1906. The author shows that the bedrock sources of the placer gold in this district include the igneous intrusive rocks and the Cretaceous sediments at or near their contacts with the intrusives; also that the auriferous lodes thus far found are closely associated with dikes and other intrusive rocks. These conditions augur well for the future of the mining industry of the region, for similar conditions exist in other parts of Alaska where gold mining is successfully carried on.

BULLETIN 579. Reconnaissance of oil and gas fields in Wayne and McCreary counties, Ky., by M. J. Munn. 1914. 105 pages, 6 plates, 6 text figures.

Gives a brief description of the stratigraphy and structure of the rocks in Wayne and McCreary counties, Ky., with especial reference to their oil and gas content. The oil and gas fields are treated in detail, and numerous records of wells are given. As to the future of the area, there is every reason to suppose that many other profitable oil pools will be found eventually in districts in and adjacent to Wayne County, and the structural conditions seem to favor the practical application of geology in finding these pools. The illustrations include sketch maps showing the location of oil and gas pools, sections of deep wells, and views of specimens from the Beaver Creek oil "sand."

BULLETIN 580. Contributions to economic geology (short papers and preliminary reports), 1913, Part I, Metals and nonmetals except fuels. F. L. Ransome and H. S. Gale, geologists in charge. 1915. 462 pages, 9 plates, 97 text figures.

This bulletin is made up of 16 brief reports on investigations of mineral deposits except fuels in the United States in 1913. The papers included are of the two classes indicated for Bulletin 541 (p. 19). A list of the papers, arranged according to subjects, is given below:

Gold and silver.

Gold placers on Wind and Bighorn rivers, Wyoming, by F. C. Schrader.

Lode deposits of the Alleghany district, California, by H. G. Ferguson.

The Rochester mining district, Nevada, by F. C. Schrader.

Copper.

Notes on the Unaweep copper district, Colorado, by B. S. Butler.

The Grand Gulch mining region, Mohave County, Ariz., by J. M. Hill.

Lead and zinc.

The Darwin silver-lead mining district, California, by Adolph Knopf.

Some cerusite deposits in Custer County, Colo., by J. F. Hunter.

Ore deposits in the Sawtooth quadrangle, Blaine and Custer counties, Idaho, by J. B. Umpleby.

Rare metals.

Carnotite near Mauch Chunk, Pa., by E. T. Wherry.

The rutile deposits of the eastern United States, by T. L. Watson.

Phosphates.

The phosphate deposits of South Carolina, by G. S. Rogers.

The Elliston phosphate field, Montana, by R. W. Stone and C. A. Bonine.

Salines.

Salines in the Owens, Searles, and Panamint basins, southeastern California, by H. S. Gale.

Miscellaneous.

A new gypsum deposit in Iowa, by G. F. Kay.

Some deposits of mica in the United States, by D. B. Sterrett.

Publications by Survey authors on metals and nonmetals except fuels, compiled by I. P. Evans.

BULLETIN 581. Contributions to economic geology (short papers and preliminary reports), 1913, Part II, Mineral fuels. M. R. Campbell and David White, geologists in charge. 1915. 187 pages, 11 plates, 6 text figures.

This bulletin includes six brief reports of the two classes indicated for Bulletin 541 (p. 19). A list of the papers follows:

Petroleum and natural gas.

Oil shale of northwestern Colorado and northeastern Utah, by E. G. Woodruff and D. T. Day.

Oil and gas in the western part of the Olympic Peninsula, Wash., by C. T. Lupton.

The Moorcroft oil field, Crook County, Wyo., by V. H. Barnett.

Possibilities of oil in the Big Muddy dome, Converse and Natrona counties, Wyo., by V. H. Barnett.

Geology and oil prospects in Waltham, Priest, Bitterwater, and Peachtree valleys, Cal., by R. W. Pack and W. A. English.

Coal.

The Coalville coal field, Utah, by C. H. Wegemann.

BULLETIN 582. Mineral deposits of the Santa Rita and Patagonia mountains, Arizona, by F. C. Schrader, with contributions by J. M. Hill. 1915. 373 pages, 25 plates, 46 text figures.

The purpose of this paper is to furnish a general idea of the character, occurrence, distribution, and development of the mineral resources of a desert area comprising about 1,400 square miles in Pima and Santa Cruz counties, Ariz., 26 miles southeast of Tucson. The physiography, geology, and water supply of the area are briefly discussed, and the mining districts, camps, and properties are considered in detail. The deposits include gold, silver, copper, lead, zinc, tungsten, molybdenum, and building materials. Topographic and geologic maps of the area discussed and of parts of it, maps, plans, and sections of some of the mines and their workings, and halftone plates showing geologic features make up the illustrations.

BULLETIN 583. Colorado ferberite and the wolframite series, by F. L. Hess and W. T. Schaller. 1914. 75 pages, 14 plates, 35 text figures.

This report is made up of two papers, namely, "The mineral relations of ferberite," by Mr. Hess, and "Crystallography of ferberite from Boulder County, Colo.," by Mr. Schaller. Ferberite, as ordinarily defined, is that mineral of the wolframite series which is composed wholly or almost wholly of iron tungstate and which, like other wolframites, crystallizes in the monoclinic system. It is comparatively rare and where found seems to occur in small quantities only. It occurs in largest quantity in the locality described in this report. The illustrations of Bulletin 583 include diagrams and halftone plates representing crystals of ferberite.

BULLETIN 584. Bibliography of North American geology for 1913, with subject index, by J. M. Nickles. 1914. 183 pages.

A list, arranged alphabetically by authors' names, of publications on the geology of the continent of North America and adjacent islands, also Panama and the Hawaiian Islands, issued in 1913. The work is indexed and contains lists of chemical analyses reported and minerals, rocks, and formations described.

BULLETIN 586. Slate in the United States, by T. N. Dale and others. 1914. 220 pages, 26 plates, 18 text figures.

This volume is not only a corrected and revised edition of Bulletin 275, "Slate deposits and slate industry of the United States," but also contains the results of all recent discoveries and studies of slate in this country. Its plan is (1) to set forth, in succinct form, the present state of scientific knowledge as to the origin, structure, texture, and chemical and mineral composition of slate; (2) to describe in more or less detail the slates and quarries of each district; and (3) to consider the economic geology of slate, including scientific prospecting for it, methods of testing it, slate machinery, and the uses of slate and slate waste, together with a tabular summary of the slates described. The book is illustrated by numerous maps showing the location of slate deposits and quarry sites in New England, the Middle Atlantic States, and Arkansas, and halftone plates showing some of the quarries.

BULLETIN 588. The constitution of the natural silicates, by F. W. Clarke. 1914. 128 pages.

This bulletin represents the results of a study of the chemical structure of the silicates found in the solid crust of the earth. From the geologist's point of view the silicates are of fundamental importance, for they form at least nine-tenths of the entire known mass of the earth's crust, and a study of their inner constitution may be reasonably expected to shed light upon many serious problems. Every primitive rock or eruptive mass contains an aggregation of silicates, each one capable of undergoing chemical change by which alteration products are formed, so that in time the rock may become transformed into new substances, quite unlike those which originally existed in it. A knowledge of the processes which thus occur, dependent on chemical structure, should be applicable to the study of the rocks and should ultimately render it possible so to investigate a metamorphosed mass as to clearly indicate its origin.

BULLETIN 589. The calcite marble and dolomite of eastern Vermont, by T. N. Dale. 1914. 67 pages, 2 plates, 11 text figures.

A companion report to Bulletin 521, "The commercial marbles of western Vermont," by the same author. The region discussed in the earlier report includes the most extensive marble industry in the United States, whereas Bulletin 589 relates to a virgin field whose development is still a work of the future. The object of this bulletin is twofold—to locate definitely and describe accurately the marbles and dolomites of eastern Vermont with a view to setting forth their possible economic uses and to discuss whatever features of scientific interest they may present. To this end the deposits are treated in detail by counties and towns. The illustrations include a map of the State and maps of many of the townships, showing the marble and dolomite localities described.

BULLETIN 590. Reconnaissance of the geology and oil prospects of northwestern Oregon, by C. W. Washburne. 1914. 111 pages, 1 plate.

This report is based on a hasty reconnaissance, made during the summer of 1910, of a certain part of the Coast Range of Oregon, where the presence of oil had been suggested by the topographic similarity of the locality to the oil regions of California. It contains a brief description of the geology of the district as a whole and of each county, as well as discussions of the oil and gas indications in each county. The author concludes that there is no good reason for believing that oil will be found in the northern part of the Coast Range of Oregon. A map of northwestern Oregon showing gas and oil prospects accompanies the report.

BULLETIN 592. Mineral resources of Alaska—report on progress of investigations in 1913, by A. H. Brooks and others. 1914. 413+xi pages, 17 plates, 13 text figures.

A collection of 21 papers by 13 authors on the work of the Geological Survey in Alaska during 1913. Papers of a general character are presented first, followed by those treating of special districts, arranged geographically from south to north. The book contains preliminary statements on investigations made during the year and summaries of the conditions of the mining industry, including statistics of mineral production. It is illustrated by maps showing the distribution of mineral resources in the whole Territory and in certain portions of it and by sketch maps showing the location of lode prospects in some of the districts. The titles of the papers are given below:

Administrative report, by A. H. Brooks.

The mineral deposits of Alaska, by A. H. Brooks.

The Alaskan mining industry in 1913, by A. H. Brooks.

Lode mining in the Ketchikan region, by P. S. Smith.

Marble resources of the Juneau, Skagway, and Sitka districts, by E. F. Burchard.

A barite deposit near Wrangell, by E. F. Burchard.

Mineral deposits of the Yakataga district, by A. G. Maddren.

Preliminary report on a water-power reconnaissance in south-central Alaska, by C. E. Ellsworth and R. W. Davenport.

The Port Wells gold-lode district, by B. L. Johnson.

Mining on Prince William Sound, by B. L. Johnson.

Gold lodes and placers of the Willow Creek district, by S. R. Capps.

Mineral resources of the upper Matanuska and Nelchina valleys, by G. C. Martin and J. B. Mertie, jr.

Preliminary report on the Broad Pass region, by F. H. Moffit.

Mining in the Valdez placer district, by F. H. Moffit.

The Chisana placer district, by A. H. Brooks.

Lode mining near Fairbanks, by Theodore Chapin.
Placer mining in the Yukon-Tanana region, by Theodore Chapin.
Placer mining in the Ruby district, by H. M. Eakin.
Mineral resources of the Yukon-Koyukuk region, by H. M. Eakin.
Placer mining on Seward Peninsula, by Theodore Chapin.
Lode developments on Seward Peninsula, by Theodore Chapin.

BULLETIN 594. Some mining districts in northeastern California and northwestern Nevada, by J. M. Hill. 1915. 200 pages, 19 plates, 4 text figures.

A general outline of the geology of a part of northern California and northwestern Nevada, with a brief statement of the nature and occurrence of the ore deposits as a whole and detailed descriptions of individual mining districts. In these descriptions the following points concerning the districts are considered: Location, accessibility, history, production, climate and vegetation, topography, geology, type and origin of the ore deposits, and origin and character of the veins. Sketch maps of the districts, structure sections of the mountain ranges, and halftone plates showing geologic features make up the illustrations.

BULLETIN 596. Geology and coal resources of North Park, Colo., by A. L. Beekly. 1915. 121 pages, 12 plates, 1 text figure.

Describes the geography, stratigraphy, structure, and economic geology of North Park, a great natural depression in the Rocky Mountains of northern Colorado, sharply defined as a topographic unit by its prominent, almost continuous rim of mountain crests 2,000 to 5,000 feet above the bottom of the basin. On account of its remoteness from frequented routes of travel, very little has been known of the geology of this basin until recent years. As coal is the most valuable known mineral resource of North Park, this report calls special attention to the coal deposits, discussing their occurrence and development and the production and estimated tonnage of the mines. The illustrations consist of a geologic map and sections of North Park, sections of coal beds, and photographic views of geologic features.

BULLETIN 599. Our mineral reserves—how to make America industrially independent, by G. O. Smith. 1914. 48 pages.

The readjustments in the world's commerce necessitated by the European war have already imposed new conditions on the mineral industry as well as on other industries. Second only in importance to the food supply is the supply of mineral products necessary to meet the requirements of twentieth-century civilization. The United States has cause for congratulation in the facts that it is almost independent in the possession of essential mineral resources and that the interference with manufacturing caused by interruption of the importation of many necessary raw materials may be overcome almost wholly by development of neglected resources in our own country. Beginning in August, 1914, there was a lively demand for information regarding possible sources of mineral products, both crude and manufactured. Bulletin 599 was issued for the purpose of furnishing to the public in convenient form a summary of the mineral resources available for utilization under the pressure of present conditions, in the hope of encouraging their development and discouraging the importation of raw material and products which can be supplied at home.

BULLETIN 600. The Glacier National Park: a popular guide to its geology and scenery, by M. R. Campbell. 1914. 54 pages, 13 plates, 13 text figures.

Describes briefly the geology and scenery of the Glacier National Park, which was set apart by act of Congress in 1910 and includes that part of the Front Range of the Rocky Mountains lying just south of the Canadian line in Teton and Flathead counties, Mont. Illustrated by a topographic map of the park, diagrams showing geologic features, and halftone plates depicting some of the wonderful scenery to be found and enjoyed there.

Bulletin 612. Guidebook of the western United States, Part B, The Overland Route, with a side trip to Yellowstone Park, by W. T. Lee, R. W. Stone, H. S. Gale, and others. 1915. 244 pages, 29 route maps, 50 plates, 20 text figures.

A handbook for the traveler which deals not only with the geology but with the natural resources, history, and development of the country between Omaha and San Francisco. It shows how differences in scenery and climate depend upon past geologic events and dispels the monotony of the Great Plains by taking the traveler back to times when these regions supported a vegetation very different from their present scanty covering and were inhabited by animals of strange forms and huge size. The scenery of the mountains acquires additional interest from the explanation of the earth movements and the resulting rock structure to which fundamentally the mountain forms are due. Even the desert becomes attractive when the traveler is told of its vanished lakes and is shown the old beach lines which their waves cut in the now arid hillsides.

The book is intended to educate by being interesting, to win hearing for the story of geology by telling it in a clear and simple way, with abundant illustration from the car windows not only of the story itself but of its intimate connection with human life.

The text deals with the route consecutively from east to west and is accompanied by a series of conveniently folded maps and by abundant halftone cuts and diagrams. Matter slightly more technical or detailed than is comprised in the body of the text, although not necessarily less interesting on that account, has been printed as footnotes.

Bulletin 620–A. A gold-platinum-palladium lode in southern Nevada, by Adolph Knopf. 1915. pp. 1–18, Pl. I, fig. 1.

Part of Bulletin 620, "Contributions to economic geology, 1915, Part I." A brief description of the geology of the district surrounding the Boss copper mine, in the Yellow Pine mining district, Clark County, Nev., at which platinum-bearing gold ore was discovered in 1914. The development of the mine and the genesis of the ore are discussed and a review is given of the known lode occurrences of platinum. Great interest attaches to so unusual and remarkable an occurrence of platinum and palladium in a gold-bearing lode. The Boss vein is one of the few primary deposits in which metals of the platinum group occur in more than traces and, with one possible exception (the New Rambler mine in Wyoming), is the only primary deposit of economic importance in which these metals are the constituents of predominant value.

Water-Supply Paper 312. Surface water supply of the United States, 1911, Part XII, North Pacific coast drainage basins, prepared under the direction of M. O. Leighton by F. F. Henshaw, G. C. Baldwin, G. C. Stevens, and E. S. Fuller. 1915. 706 pages, 4 plates.

Presents briefly the results of measurements of flow made on streams of the north Pacific coast of the United States during the calendar year 1911. Data for each gaging station are given under the following headings: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Accuracy, and Cooperation. The book also contains tables giving gage heights and daily and monthly discharges at each station, lithographed maps showing the mean annual precipitation and run-off in the United States, and halftone plates representing typical gaging stations and current meters.

Water-Supply Paper 321. Surface water supply of the United States, 1912, Part I, North Atlantic coast basins, by C. C. Babb, C. C. Covert, and J. G. Mathers. 1914. 240 pages, 3 plates.

Water-Supply Paper 325. Surface water supply of the United States, 1912, Part V, Upper Mississippi River and Hudson Bay basins, by A. H. Horton, W. G. Hoyt, and H. J. Jackson. 1914. 193 pages, 2 plates.

WATER-SUPPLY PAPER 326. Surface water supply of the United States, 1912, Part VI, Missouri River basin, by W. A. Lamb, Robert Follansbee, and H. D. Padgett. 1914. 375 pages, 2 plates.

WATER-SUPPLY PAPER 327. Surface water supply of the United States, 1912, Part VII, Lower Mississippi River basin, by Robert Follansbee. 1914. 84 pages, 2 plates.

WATER-SUPPLY PAPER 328. Surface water supply of the United States, 1912, Part VIII, Western Gulf of Mexico basins, by W. W. Follett, Robert Follansbee, and G. A. Gray. 1914. 121 pages, 2 plates.

WATER-SUPPLY PAPER 329. Surface water supply of the United States, 1912, Part IX, Colorado River basin, by Robert Follansbee, E. A. Porter, and H. D. Padgett. 1914. 238 pages, 2 plates.

WATER-SUPPLY PAPER 330. Surface water supply of the United States, 1912, Part X, The Great Basin, by F. F. Henshaw, E. A. Porter, and G. C. Stevens. 1914. 275 pages, 3 plates.

WATER-SUPPLY PAPER 331. Surface water supply of the United States, 1912, Part XI, Pacific coast basins in California, by H. D. McGlashan and G. C. Stevens. 1914. 442 pages, 2 plates.

WATER-SUPPLY PAPER 332–A. Surface water supply of the Pacific drainage basins in Washington and upper Columbia River basin, 1912, by F. F. Henshaw and W. A. Lamb. 1915. 282 pages, 2 plates.

WATER-SUPPLY PAPER 332–C. Surface water supply of lower Columbia River and Rogue, Umpqua, and Siletz rivers, 1912, by F. F. Henshaw and E. S. Fuller. 1914. 226 pages.

These reports present briefly the results of measurements of stream flow made in the drainage basins named during the calendar year 1912. Data for each gaging station are given under the following headings: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Artificial control, Winter flow, Accuracy, and Cooperation. The books also contain tables giving gage heights and daily and monthly discharges at each station, and halftone plates representing typical gaging stations and current meters.

WATER-SUPPLY PAPER 335. Geology and underground waters of the southeastern part of the Texas Coastal Plain, by Alexander Deussen. 1914. 365 pages, 6 plates, 17 text figures.

The area discussed in this report embraces 36,317 square miles and includes that part of the Coastal Plain of Texas lying east of Brazos River and south of a line extending east and west through Jefferson, in Marion County. The paper includes a brief description of the geology of this area, with special reference to the underground-water horizons, and discussions of the quality of the water and artesian conditions and prospects in each of the several counties, as well as a geologic map of a part of eastern Texas, maps of several of the artesian reservoirs, maps showing the distribution of timber and the mean annual rainfall and run-off, and diagrams and sections showing ground-water conditions.

WATER-SUPPLY PAPER 336. Water resources of Hawaii, 1912, by C. H. Pierce and G. K. Larrison. 1914. 392 pages.

This volume contains results of measurements of the flow of certain streams and ditches in the Territory of Hawaii made during the calendar year 1912.

WATER-SUPPLY PAPER 338. Springs of California, by G. A. Waring. 1915. 410 pages, 13 plates, 4 text figures.

As a basis for the discussion of springs and spring waters of California this paper opens with a brief outline of the physical features of the State, together with a few notes on the character of the rocks and their structure, then proceeds to explain the usual or possible composition and properties of most natural waters as well as the source of their constituent substances, and concludes with discussions of the springs of California classified under the following groups: Hot, carbonated, sulphur, saline, magnesic, iron, artesian, large cold, and minor perennial springs. Accompanying the discussions of many of the springs are analyses of their waters, and at the end of the book are two tables, one of which gives an alphabetic list, by counties, of the best-known springs of the State, with name of owner, location, temperature, and yield, and the other a list of California spring resorts. The illustrations consist of lithologic and topographic maps of the State, showing locations of springs, and photographs of many of the springs and their environs.

WATER-SUPPLY PAPER 339. Quality of the surface waters of Washington, by Walton Van Winkle. 1914. 105 pages, 2 plates, 1 text figure.

A brief discussion of the constituents, uses, and purification of natural waters and a detailed consideration, by drainage basins, of the quality of the stream waters of Washington, showing the nature and amount of the material they hold in solution. The book contains many analyses.

WATER-SUPPLY PAPER 340-C. Stream-gaging stations and publications relating to water resources, 1885–1913, Part III, Ohio River basin, compiled by B. D. Wood. 1914. pp. i–xxii, 31–42.

WATER-SUPPLY PAPER 340-D. Stream-gaging stations and publications relating to water resources, 1885–1913, Part IV, St. Lawrence River basin, compiled by B. D. Wood. 1914. pp. i–xx, 43–52.

WATER-SUPPLY PAPER 340-E. Stream-gaging stations and publications relating to water resources, 1885–1913, Part V, Hudson Bay and upper Mississippi River drainage basins, compiled by B. D. Wood. 1914. pp. i–xxi, 53–61.

WATER-SUPPLY PAPER 340-F. Stream-gaging stations and publications relating to water resources, 1885–1913, Part VI, Missouri River basin, compiled by B. D. Wood. 1915. pp. i–xxiii, 63–81.

WATER-SUPPLY PAPER 340-G. Stream-gaging stations and publications relating to water resources, 1885–1913, Part VII, Lower Mississippi River basin, compiled by B. D. Wood. 1915. pp. i–xxi, 83–93.

WATER-SUPPLY PAPER 340-H. Stream-gaging stations and publications relating to water resources, 1885–1913, Part VIII, Western Gulf of Mexico drainage basins, compiled by B. D. Wood. 1915. pp. i–xx, 95–104.

WATER-SUPPLY PAPER 340-I. Stream-gaging stations and publications relating to water resources, 1885–1913, Part IX, Colorado River basin, compiled by B. D. Wood. 1915. pp. i–xxiii, 105–116.

WATER-SUPPLY PAPER 340-J. Stream-gaging stations and publications relating to water resources, 1885–1913, Part X, The Great Basin, compiled by B. D. Wood. 1915. pp. i–xxi, 117–129.

WATER-SUPPLY PAPER 340-K. Stream-gaging stations and publications relating to water resources, 1885–1913, Part XI, Pacific coast basins in California, compiled by B. D. Wood. 1915. pp. i–xxiv, 131–146.

Parts of Water-Supply Paper 340, a directory of Survey stream-gaging stations and publications relating to water resources of the United States. Each part contains a list of all gaging stations maintained in the section named in its title and an annotated list of publications issued by the United States Geological Survey relating specifically to that section, as well as a similar list of reports that are of general interest, covering a wide range of hydrologic subjects, and brief references to reports published by State and other organizations.

Water-Supply Paper 340-C pertains to the Ohio River basin, which includes Ohio River with all its tributaries, the most important being Allegheny, Monongahela, Beaver, Muskingum, New (or Kanawha), Scioto, Miami, Kentucky, Wabash, Cumberland, and Tennessee rivers. These streams drain wholly or in part the

States of Alabama, Georgia, Illinois, Indiana, Kentucky, Mississippi, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia.

Water-Supply Paper 340–D pertains to the United States portion of the St. Lawrence River basin, which includes streams that drain into the Great Lakes and St. Lawrence River from the United States. These streams drain wholly or in part the States of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Vermont, and Wisconsin.

Water-Supply Paper 340–E pertains to the United States portion of the Hudson Bay and upper Mississippi River basins, which include streams (from the United States) whose waters reach Hudson Bay and the Mississippi above its junction with the Ohio (except the Missouri). These streams drain wholly or in part the States of Illinois, Indiana, Iowa, Minnesota, Missouri, Montana, North Dakota, South Dakota, and Wisconsin.

Water-Supply Paper 340–F pertains to the Missouri River basin, which includes Missouri River and all its tributaries, the most important being Jefferson, Madison, Gallatin, Prickly Pear, Little Prickly Pear, Dearborn, Sun, Marias, Judith, Musselshell, Milk, Yellowstone, Little Muddy, Little Missouri, Cheyenne, Niobrara, Platte (including North Platte and South Platte), Kansas, Osage, and Gasconade rivers. These streams drain wholly or in part the States of Colorado, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, and Wyoming.

Water-Supply Paper 340–G pertains to the lower Mississippi River basin, which includes the main stream and all its tributaries below the mouth of the Ohio, the most important tributaries being Meramec, White, Arkansas, Yazoo, Homochitto, and Red rivers. These streams drain wholly or in part the States of Arkansas, Colorado, Kansas, Kentucky, Louisiana, Mississippi, Missouri, New Mexico, Oklahoma, Tennessee, and Texas.

Water-Supply Paper 340–H pertains to the western Gulf of Mexico basins, which include all streams draining into the Gulf of Mexico west of the mouth of the Mississippi and into the Rio Grande. The largest of these streams are the Rio Grande, Sabine, Trinity, and Brazos rivers, Colorado River of Texas, Guadalupe and Chama rivers, Rio Puerco and Pecos River, in the United States, and Rio Salado and Rio San Juan in Mexico, draining wholly or in part the States of Colorado, Louisiana, New Mexico, Texas, and the northern States of Mexico.

Water-Supply Paper 340–I pertains to the Colorado River basin, which includes Green, Grand, Dolores, San Juan, Little Colorado, Virgin, and Gila rivers. These streams drain wholly or in part the States of Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming.

Water-Supply Paper 340–J pertains to the Great Basin, which is made up of a number of minor basins whose streams do not discharge into the ocean. The largest of these minor basins are the depressions that hold Great Salt Lake, Sevier Lake, Humboldt Sink, Truckee, Walker, Carson, and Owens rivers, and Honey, Mono, Malheur, Harney, Warner, Abert, Summer, and Silver lakes. The streams of this section drain wholly or in part the States of California, Idaho, Nevada, Oregon, and Utah.

Water-Supply Paper 340–K pertains to the Pacific coast basins in California, which include Tia Juana, Sweetwater, San Diego, Bernardo, San Luis Rey, and Los Angeles rivers, draining areas to the south of San Francisco Bay; and San Joaquin, Sacramento, Russian, Eel, Mad, and Klamath rivers, which flow into the ocean through San Francisco Bay or north of it. With the exception of Klamath River and a few streams in Oregon that flow into Goose Lake, at the head of Pit River, all the streams in this division are entirely in California.

WATER-SUPPLY PAPER 341. Underground waters of the Coastal Plain of Georgia, by L. W. Stephenson and J. O. Veatch, and a discussion of the quality of the waters, by R. B. Dole. 1915. 539 pages, 21 plates, 4 text figures.

Gives the results of investigations made to determine the composition, structure, and stratigraphic relations of the formations of the Coastal Plain of Georgia and the geologic position, quality, quantity, and economic adaptability of the waters they contain. These topics are discussed first as applicable to the Georgia Coastal Plain as a whole and then as applicable to each county in this geologic province. Mr. Dole, who discusses the quality of the waters, concludes that all the underground waters of this province may be used advantageously for domestic and industrial purposes, although those from the later formations may require a little softening. He thinks also that the surface waters of this section are even better for industrial use than the ground waters, because they are lower in mineral content. The illustrations include a geologic map of the Coastal Plain of Georgia, a map of the underground water resources, a sketch map showing the relation of the drainage to the geologic structure, and halftone plates showing typical formations exposed by railroad cuts.

WATER-SUPPLY PAPER 342. Surface water supply of the Yukon-Tanana region, Alaska, by C. E. Ellsworth and R. W. Davenport. 1915. 343 pages, 13 plates, 5 text figures.

Describes briefly the general features of the Yukon-Tanana region, such as the geography, geology, climate, and water supply, and gives an account of the stream-measurement work and the establishment of gaging stations, with an explanation of the methods of carrying on the work and collecting the data. Contains tables showing the daily gage height and discharge of the various streams, and maps and other illustrations showing the hydraulic development of the region.

WATER-SUPPLY PAPER 343. Geology and water resources of Tularosa Basin, New Mexico, by O. E. Meinzer and R. F. Hare. 1915. 317 pages, 19 plates, 51 text figures.

Describes the physiography, drainage, and geology of Tularosa Basin, New Mexico, with special reference to its underground water resources and their availability for use in irrigation. Tularosa Basin, which includes about 6,000 square miles of arable land entirely shut in by mountain ranges so that it has no drainage outlets, is dependent upon its scanty rainfall and underground water for the growing of its crops. The paper outlines the routes of travel through the basin, briefly describing the watering places to be found on these routes, and contains analyses of some of the well, spring, and stream waters in this and adjoining areas. The illustrations include maps of the basin and adjacent country showing ground-water conditions, maps showing settlements, diagrams showing precipitation and its relation to altitude and other features, and sections of wells.

WATER-SUPPLY PAPER 344. Deschutes River, Oregon, and its utilization, by F. F. Henshaw, J. H. Lewis, and E. J. McCaustland. 1914. 200 pages, 28 plates, 8 text figures.

This report describes the general features of the Deschutes River basin and gives in concise form the results of measurements of stream flow for 1912 at each gaging station. It includes sections on the availability of the water supply, the economic distribution of the water, and the developed and undeveloped water sites, as well as a brief discussion of the old and new laws relating to water (which is necessary for a proper understanding of the water-right situation) and the relation of the Federal Government to the development of water power in this basin. Deschutes River is unique among western rivers in that its natural flow is constant and its headwaters afford reservoir sites so large and so well distributed that the total flow of the river may be utilized both for irrigation and for power. The paper is illustrated by a map of the basin showing the position of the gaging stations, plans and profiles of Deschutes and Metolius rivers, and maps of many of the power sites. The report was prepared in cooperation with the State of Oregon.

WATER-SUPPLY PAPER 345–E. A method of determining the daily discharge of rivers of variable slope, by M. R. Hall, W. E. Hall, and C. H. Pierce. 1914. pp. 53–65, figs. 1–2.

WATER-SUPPLY PAPER 345–F. The discharge of Yukon River at Eagle, Alaska, by E. A. Porter and R. W. Davenport. 1914. pp. 67–77, Pls. IV–V, figs. 3–4.

Parts of Water-Supply Paper 345, "Contributions to the hydrology of the United States, 1914."

WATER-SUPPLY PAPER 345–G. The water resources of Butte, Montana, by O. E. Meinzer. 1914. pp. 79–125, Pls. VI–VIII, figs. 5–8.

Part of Water-Supply Paper 345. Gives the results of an investigation of the water resources of the small rock-bound basin in the center of which is situated the city of Butte, Mont. The investigation was made in response to an urgent request from the citizens of Butte for information as to the supply of ground water in the flat and the feasibility of developing it for industrial uses and for irrigation. The author concludes that the bedrock in this area forms a nearly water-tight basin but contains small quantities of water near the surface, where the rock is partly disintegrated, and in joints at greater depths. This bedrock will yield enough water in small quantities for domestic use but not enough for irrigation or industrial use. The deposits of clay, sand, and gravel which partly fill the basin are saturated with water below the water table, so that with proper methods of construction a yield of 100 gallons a minute from a single well can probably be developed in most parts of the flat, but flows of large volume should not be expected. The illustrations include a map of the basin discussed, showing water resources, a map of Silverbow Creek near Butte, and a diagram showing average monthly precipitation at Butte.

WATER-SUPPLY PAPER 345–H. Ground-water resources of the Niles cone and adjacent areas, California, by W. O. Clark. 1915. pp. 127–168, Pls. IX–XVII, figs. 9–24.

Part of Water-Supply Paper 345. Discusses briefly the physiography, drainage, and origin of ground-water supply of an area comprising the so-called Niles cone (the alluvial fan of Alameda Creek) and adjacent tracts in Santa Clara Valley, Cal., just east of the south end of San Francisco Bay, and describes the geologic formations in relation to ground water. This region is one of intensive farming, dependent on irrigation, and for more than 20 years there has been contention between the farmers and certain water companies that take large supplies from the Niles cone and tributary drainage basins to San Francisco and other cities on the bay. In the investigation resulting in this report an attempt was made to determine the source of the ground water, the quantity now being withdrawn, the amount available, and the area dependent on Alameda Creek. The author concludes that the ground-water supply is hardly adequate for the full irrigation of the area and the present-scale diversions by the water companies. The illustrations include maps of the area, well sections, and graphs showing fluctuations of the water table.

WATER-SUPPLY PAPER 345–I. Gazetteer of surface waters of Iowa, by W. G. Hoyt and H. J. Ryan. 1915. pp. 169–221.

Part of Water-Supply Paper 345. Embraces descriptions of all the streams named on the best available maps of Iowa, including the United States Geological Survey's base map of the State, county maps published in the annual report of the Iowa Geological Survey, and the topographic atlas sheets of the United States Geological Survey.

Water-Supply Paper 346. Profile surveys in the basin of Clark Fork of Columbia River, Montana-Idaho-Washington, prepared under the direction of R. B. Marshall, chief geographer. 1914. 6 pages, 3 plates.

Describes briefly the general features of the Clark Fork basin and gives a list of the gaging stations maintained by the Geological Survey on the main stream and its tributaries. The paper contains plans and profiles showing the fall in the stream and conditions along the bank between Deer Lodge, Mont., and the international boundary.

Water-Supply Paper 347. Profile surveys in Snake River basin, Idaho, prepared under the direction of R. B. Marshall, chief geographer. 1914. 12 pages, 3 plates.

Describes briefly the general features of the Snake River basin and gives a list of the gaging stations maintained by the Geological Survey on the main stream and its tributaries. The paper contains plans and profiles showing the fall in the streams and conditions along the banks of Snake River from Enterprise to Minidoka and of Salmon River from Salmon to its junction with Snake River.

Water-Supply Paper 348. Profile surveys in Hood and Sandy River basins, Oregon, prepared under the direction of R. B. Marshall, chief geographer. 1914. 8 pages, 2 plates.

Describes briefly the general features of the Hood and Sandy River basins and gives lists of the gaging stations maintained by the Geological Survey on the two main streams and their tributaries. Contains plans and profiles of Hood River and of Sandy and Zigzag rivers and Camp and Still creeks above Marmot, Oreg.

Water-Supply Paper 349. Profile surveys in Willamette River basin, Oregon, prepared under the direction of R. B. Marshall, chief geographer. 1915. 9 pages, 3 plates.

Describes briefly the general features of the Willamette River basin and gives a list of the gaging stations maintained by the Geological Survey on the main stream and its tributaries. Contains plans and profiles of Middle Fork of Willamette River and tributaries, Clackamas and Collawash rivers, and North Fork of Santiam River and tributaries.

Water-Supply Paper 350. Profile surveys in Bear River basin, Idaho, prepared under the direction of R. B. Marshall, chief geographer. 1915. 7 pages, 1 plate.

Describes briefly the general features of the Bear River basin and gives a list of the gaging stations maintained by the Geological Survey on the main stream and its tributaries above the mouth of Logan River. Contains a plan and profile of the river from Riverdale to Novena, Idaho.

Water-Supply Paper 353. Surface water supply of the United States, 1913, Part III, Ohio River basin, by A. H. Horton, W. E. Hall, and H. J. Jackson. 1915. 264 pages, 5 plates.

Water-Supply Paper 354. Surface water supply of the United States, 1913, Part IV, St. Lawrence River basin, by C. C. Covert and W. G. Hoyt. 1915. 136 pages, 2 plates.

Water-Supply Paper 356. Surface water supply of the United States, 1913, Part VI, Missouri River basin. N. C. Grover, chief hydraulic engineer. 1915. 291 pages, 2 plates.

Water-Supply Paper 357. Surface water supply of the United States, 1913, Part VII, Lower Mississippi River basin, by Robert Follansbee and G. A. Gray. 86 pages, 2 plates.

Water-Supply Paper 358. Water resources of the Rio Grande basin, 1888–1913, by Robert Follansbee and H. J. Dean, including Surface water supply of the United States, 1913, Part VIII, Western Gulf of Mexico basins, by Robert Follansbee, W. W. Follett, and G. A. Gray. 1915. 724 pages, 3 plates.

These reports present briefly the results of measurements of stream flow made in the drainage basins named during the calendar year 1913 and in the Rio Grande basin during the years 1888 to 1913, inclusive. Data for each gaging station are given under the following headings: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Artificial control, Winter flow, Accuracy, and Cooperation. The books contain also tables giving gage heights and daily and monthly discharges at each station and halftone plates representing typical gaging stations and current meters. Water-Supply Paper 353 gives, in addition, views of two bridges over Miami River at Hamilton, Ohio, taken during the flood of March–April, 1913, and Water-Supply Paper 358 contains a map of the Rio Grande basin showing the location of gaging stations and mean annual precipitation in New Mexico and Texas.

WATER-SUPPLY PAPER 363. Quality of the surface waters of Oregon, by Walton Van Winkle. 1914. 137 pages, 2 plates, 1 text figure.

A brief discussion of the constituents, uses, and purification of natural waters and a detailed consideration, by drainage basins, of the quality of the stream waters of Oregon, showing the nature and amount of the materials they hold in solution. The paper contains many analyses, which show that the river waters of Oregon are low in mineral content and are very good for general industrial use and for irrigation. The report was prepared in cooperation with the State of Oregon.

WATER-SUPPLY PAPER 364. Water analyses from the laboratory of the United States Geological Survey, tabulated by F. W. Clarke, chief chemist. 1914. 40 pages.

Contains 203 analyses, made in the chemical laboratory of the United States Geological Survey, of waters from rivers, lakes, wells, and springs in the United States as well as some mine waters. Most of these analyses have been published elsewhere, but many of the original documents are out of print and are therefore obtainable with difficulty.

WATER-SUPPLY PAPER 365. Ground water in southeastern Nevada, by Everett Carpenter. 1915. 86 pages, 5 plates, 3 text figures.

Gives an outline of the geography and geology of an arid region comprising about 17,000 square miles in Clark, Lincoln, Nye, and White Pine counties, Nev., and discusses the quality and source of its water supply. The watering places on routes of travel are briefly described and there is a table giving the approximate distances, in miles, between the chief watering places in this section of the State. The illustrations consist of maps of the area discussed, a diagram showing average monthly precipitation at several stations, sections across Spring Mountain, and halftone plates showing types of flowing wells in Las Vegas Valley and other geologic features.

WATER-SUPPLY PAPER 366. Profile surveys of Snoqualmie, Sultan, and Skykomish rivers, Washington, prepared under the direction of R. B. Marshall, chief geographer. 1914. 7 pages, 3 plates.

Describes briefly the general features of the Snohomish River basin and gives a list of the gaging stations maintained by the Geological Survey in the area drained by Snoqualmie, Sultan, and Skykomish rivers. Snohomish River is formed by the union of Skykomish and Snoqualmie rivers in the southwestern part of Snohomish County, Wash., and flows northwestward into Puget Sound. The paper contains plans and profiles showing the fall in the stream and conditions along the banks of Snoqualmie River and certain tributaries above Fall City, Sultan River above Sultan, and Skykomish River and certain tributaries above Gold Bar.

WATER-SUPPLY PAPER 367. Profile surveys of Missouri River from Great Falls to Three Forks, Mont., prepared under the direction of R. B. Marshall, chief geographer. 1914. 8 pages, 1 plate.

Describes briefly the general features of the Missouri River basin and gives a list of the gaging stations on the main stream in Montana maintained by the Geological Survey. Contains a plan and profile of the river from Great Falls to Three Forks, Mont.

Water-Supply Paper 368. Profile surveys in Wenatchee River basin, Washington, prepared under the direction of R. B. Marshall, chief geographer. 1914. 7 pages, 1 plate.

Describes briefly the general features of the Wenatchee River basin and gives a list of the gaging stations maintained by the Geological Survey on the main stream and its tributaries. Contains a plan and profile of Wenatchee Lake, Wenatchee River, and certain tributaries.

Water-Supply Paper 375-A. Ground water for irrigation in the Sacramento Valley, California, by Kirk Bryan. 1915. pp. 1-49, Pls. I-II, figs. 1-6.

Part of Water-Supply Paper 375, "Contributions to the hydrology of the United States, 1915." Describes briefly the geography and geology of Sacramento Valley. The water-bearing formations and the origin, movements, and development of the ground water are discussed, special attention being given to pumping problems. A relief map of northern California, showing outlines of Sacramento Valley, and an outline map of the valley, showing pumping areas and depth to water, as well as diagrams of the fluctuations of the water table at different points in the valley, make up the illustrations.

Water-Supply Paper 375-C. The relation of stream gaging to the science of hydraulics, by C. H. Pierce and R. W. Davenport. 1915. pp. 77-84.

Part of Water-Supply Paper 375. Considers stream gaging as a branch of hydraulic engineering and concludes that, while a large amount of research is needed before hydraulics can be considered an exact science, yet the recent developments in stream gaging point to the possibility that this branch may in time reach a state of perfection so commensurate with the requirements imposed upon it that all problems connected therewith may be solved with mathematical exactness. When this ideal condition is attained the developments in the science of hydraulics that may be wrought by means of the current meter and the stop watch should be such as to justify the highest expectation of the most enthusiastic stream gager of to-day.

Mineral Resources of the United States, Calendar Year 1913. 1914. Part I, Metals, clxxiii+901 pages, 8 text figures; Part II, Nonmetals, vi+1,617 pages, 9 plates, 26 text figures.

Statistics of the production, importation, and exportation of mineral substances in the United States, including accounts of the chief features of mining progress, comparisons of past and present production and conditions, and the application of the products in the useful arts. Contains four inserts showing (1) mineral products of the United States since 1904, (2) clay products of the United States in 1913, (3) production of coal in the United States since 1807, and (4) production of crude petroleum in the world since 1857. A consolidation of 62 advance chapters, each covering a single mining industry or group of allied industries.

Mineral Resources of the United States, Calendar Year 1914; parts as follows:

The production of sand-lime brick in 1914, by Jefferson Middleton. 1915. pp. 1-7. Part II: 1.

Potash salts, 1914, by W. C. Phalen. 1915. pp. 9-33, Pl. I. Part II: 2.

The production of fuller's earth in 1914, by Jefferson Middleton. 1915. pp. 35-40. Part II: 3.

The production of phosphate rock in 1914, by W. C. Phalen. 1915. pp. 41-56. Part II: 4.

Fuel briquetting in 1914, by E. W. Parker. 1915. pp. 57-60. Part II: 5.

GEOLOGIC FOLIO 193. San Francisco (Cal.), folio, by A. C. Lawson. 1914. 24 folio pages of text, 10 maps, 5 structure-section sheets, 1 columnar-section sheet, 10 plates, 4 text figures. Price, 75 cents.

Description and maps of the San Francisco district, California, comprising the Tamalpais, San Francisco, Concord, San Mateo, and Haywards quadrangles, in Alameda, Contra Costa, Marin, San Francisco, and San Mateo counties. Large parts of four of these quadrangles cover the waters of the Bay of San Francisco or of the adjacent Pacific Ocean. The matter contained in this folio is to be published also in octavo form, price 75 cents.

GEOLOGIC FOLIO 194. Van Horn (Tex.) folio, by G. B. Richardson. 1914. 9 folio pages of text, 2 maps, 1 structure-section sheet, 9 plates, 6 text figures. Price, 25 cents.

Description and maps of the Van Horn quadrangle, comprising about 1,019 square miles in El Paso and Culberson counties, Tex.

GEOLOGIC FOLIO 195. Belleville-Breese (Ill.) folio, by J. A. Udden and E. W. Shaw. 1915. 13 folio pages of text, 4 maps, 1 columnar-section sheet, 13 text figures. Price, 25 cents.

Description and maps of the Belleville and Breese quadrangles, comprising about 467 square miles in Bond, Clinton, Madison, and St. Clair counties, Ill.

TOPOGRAPHIC MAPS as follows:

Alaska (Territory).[1]
Ames, Iowa.
Avena, Cal.
Axial, Colo.
Baldwin, Ill.
Battle Lake, Minn.
Benson, Ariz.
Boring, Oreg.
Burnham, Cal.
Chester, Ill.-Mo.
Chitina, Alaska.[2]
Churubusco, N. Y.
Cincinnati, Ohio-Ky.[3]
Clintwood, Va.-Ky.
Corning, N. Y.
Coshocton, Ohio.
Crawford, W. Va.
Crow Creek, Idaho-Wyo.
Crystal City, Mo.-Ill.
Cuskers, Mont.
Deerwood, Minn.
Douglas, Ariz.
East Cincinnati, Ohio-Ky.[3]
Elkhorn Weir, Cal.
Fredericktown, Ohio.
Gambier, Ohio.
Gillespie, Ill.
Grand Rapids, Mich.
Hereford, Ariz.
Hindman, Ky.
Hominy, Okla.
Hoquiam, Wash.
Houghton, Mich.
Kern River oil field, Cal. (2 sheets).[4]
Kirkville, Cal.
Lanes Creek, Idaho.
Lathrop, Cal.
Little Muddy, Ky.
Longs Peak, Colo.
Loudonville, Ohio.
Macomb, Ill.
Malaga, Wash.
Manteca, Cal.
Marengo, Ohio.
Massachusetts, Rhode Island, and Connecticut (States).[1]
Meadow Creek, W. Va.
Merritt, Cal.
Mesa, Ariz.
Mesa Verde National Park, Colo.
Milford, Pa.-N. Y.-N. J.
Milton, Vt.
Montana (State).[1]
Monument Butte, Colo.
Morenci, Ariz.-N. Mex.[5]
Mount Baker district, Wash.
Mount Morrison, Cal.-Nev.
Mount Olive, Ill.
Mount Rainier National Park, Wash.
Murphy, Tenn.-N. C.[3]
Nemaha, Nebr.-Mo.
Nowata, Okla.[6]
Number Four, N. Y.
Nyack, Mont.
Oregon (State).[1]
Oregon City, Oreg.
Ottawa, Ill.[6]
Palatka, Fla.
Perham, Minn.
Perrysville, Ohio.
Petaluma, Cal.
Peters, Cal.
Pine, Oreg.-Idaho.
Platte County, Mo.
Port Valdez, Alaska.
Pound, Va.-Ky.

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[1] Photolithograph.
[2] Reprint of Plate I, Bulletin 374.
[3] New edition; revised in field.
[4] Formerly Oil Center; revised in field and enlarged.
[5] Formerly Boyles.
[6] Resurveyed and reengraved.

Priest Valley, Cal.
Reading, Pa.[1]
Renault, Ill.-Mo.
Ronda, Cal.
Roxabell, Ohio.
Sago, W. Va.
San Francisco and vicinity, Cal.
San Francisco Bay (sheet J-10 of world map).
Seaford, Del.-Md.
Soda Canyon, Colo.
Spring Creek, Mont.
Sunnyside, Utah.
Swingle, Cal.
Todd Lakes, Mont.
Troy, Ohio.
Tule Valley, Mont.
Underwood, Minn.
Union Island, Cal.
United States (2-sheet base map).[2]
United States (2-sheet contour map).[2]
Vergas, Minn.
Vermont and New Hampshire (States).[3]
Vernalis, Cal.
Vincennes, Ind.-Ill.
Virginia (State).[3]
Walker Creek, Cal.[4]
Washington (State).[3]
West Cincinnati, Ohio-Ky.[5]
Wyoming (State).[3]
Yerington district, Nev.
Yolo, Cal.

GEOLOGIC BRANCH.

SCOPE OF WORK.

The geologic branch is responsible for the geologic work of the Survey. Its original duties, as defined in the act establishing the Survey, were "the classification of the public lands and the examination of the geological structure, mineral resources, and products of the national domain." These duties were at first construed to apply only to the public-land States. Later, however, in order that all parts of the country might share alike in the benefits of its work, the Survey was specifically authorized "to continue the preparation of a geological map of the United States," the scope of its operations being thus made nation-wide. Since that time (1882) the investigations necessary to the fulfillment of the Survey's obligations to the public have become as varied as the aspects of geology itself.

At present the geologic branch is not only the effective agency of the Survey in the geologic investigations carried on by the Government in all parts of the United States and Alaska but also the great geologic information bureau to which the American public, from Key West to Point Barrow and from San Diego to Eastport, applies for knowledge of every sort concerning the earth's crust and its mineral constituents. To the people of this country and, in a surprising degree, to the citizens of other countries, the Survey is the principal source of geologic information regarding not only the geology of the United States and its possessions but also that of Mexico, Central America, and even South America. Through its correspondence it is asked for data regarding the geology and mineral deposits of all parts of the world. The geologic branch has therefore the double task of geologic surveying, including the investigation, description, and mapping of the geology and mineral deposits of all parts of the country, the classification of the public lands, and the publication of the results of its work on the one hand, and of furnishing to the public misc laneous geologic information derived from all sources on the oth

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[1] Resurveyed and reengraved.
[2] Revised map; published in new form.
[3] Photolithograph.
[4] Preliminary edition showing part of quadrangle.
[5] New edition; revised in field.

ADMINISTRATION.

For the more efficient and systematic accomplishment of its wo the geologic branch is organized in four divisions—geology, Da White, chief geologist, in charge; Alaskan mineral resources, A. Brooks in charge; mineral resources, H. D. McCaskey in charg chemical and physical researches, G. F. Becker in charge. Th divisions, though as nearly autonomous as is practicable without lo of efficiency and strength in the organization as a whole, coopera effectively. Most of the statistical reports of the division of miner resources are prepared by members of the division of geology who specialists in the geology of the respective mineral deposits and wh field investigations give opportunities for close observation of t mineral industries. In paleontologic and other laboratory investi tions there is free exchange of assistance between the division Alaskan mineral resources and the division of geology. Field inves gations are occasionally made by members of the division of chemist and physics under the auspices of the division of geology.

The chief geologist plans the geologic investigations to be carried by the Survey in the United States and has general supervision of t work. He gives special attention to cooperation in geology with t State surveys and devotes such time as is available to him for fie work to field inspections and conferences with geologists and chi of sections and to the direction and inspection of the work of t section of eastern fuels.

PUBLICATIONS.

The publications of the fiscal year 1915 prepared wholly or part in the geologic branch embrace 1 monograph, 34 professional pape bulletins, etc., 92 chapters of reports later published as annu volumes, and 3 geologic folios. Titles and brief abstracts of the publications are given on pages 16–37. Besides the official public tions, 56 papers were, with the permission of the Director, publish in scientific journals and in the publications of scientific societi Eight reports, based on work done in cooperation with State geologic surveys, have, in accordance with the cooperative agreements, bee transmitted to the States for publication. On the other hand, thr somewhat extensive geologic reports, prepared by the State organiz tions under the same agreements, have been submitted for public tion by the Federal Survey, and others are in preparation by th States. In the preparation of the reports of mineral production som of the material relating to certain of the industries in the differen States is compiled by the State geologists.

PUBLI

AREA GEOLOGICALLY SURVEYED IN THE UNITED STATES DURING THE YEAR.

On account of the differences in the nature of the work performed, it is difficult to estimate areas covered by all the geologists in square miles of detailed areal, detailed reconnaissance, and reconnaissance mapping. However, calculations, in which examinations for inspection, paleontologic studies, revision, and local investigations have been omitted, furnish the following results for the fiscal year ended June 30, 1915.

Areas covered by geologic surveys, fiscal year 1914–15.

	Square miles.
States east of the one-hundredth meridian:	
Detailed areal	3,346
Detailed reconnaissance	1,830
Reconnaissance	36,650
States west of the one-hundredth meridian:	
Detailed areal	10,411
Detailed reconnaissance	4,705
Reconnaissance	10,705
Total in the United States:	
Detailed areal	13,757
Detailed reconnaissance	6,535
Reconnaissance	47,355

The areas in the United States covered by geologic maps published by the Survey and the general nature of the work in each area are shown on Plate I, which does not, however, indicate areas for which reports, prepared by this Survey, have been submitted for publication to cooperating State organizations or to other bureaus and departments of the Federal Government.

The progress of geologic surveying in Alaska is described in the section on the division of Alaskan mineral resources (pp. 92–99).

DIVISION OF GEOLOGY.

ORGANIZATION.

The scientific force of the division of geology at the beginning of the year consisted of 66 geologists, 33 associate geologists, 26 assistant geologists, 15 junior geologists, and 22 geologic aids. During the year eight members of the scientific staff resigned to take positions in private life at higher salaries, two members were transferred to the land-classification board, and 12 members were appointed. The total number of geologists of various grades on the staff at the end of the year was 164. Of this number, 81 were employed continuously, 35 gave only part of their time to Survey work, and 48 were not employed.

The division of geology is organized in nine sections, as follows:

1. Section of eastern areal geology (east of the one-hundredth meridian).
2. Section of western areal geology (west of the one-hundredth meridian), including the subsection of investigations in petrology.
3. Section of Coastal Plain investigations.
4. Section of glacial geology.
5. Section of paleontology and stratigraphy.
6. Section of metalliferous deposits.
7. Section of nonmetalliferous deposits.
8. Section of eastern mineral fuels (east of the one-hundredth meridian).
9. Section of western mineral fuels (west of the one-hundredth meridian).

The section of geologic-map editing, although a part of the publication branch, comes under the general supervision of the chief geologist.

ALLOTMENTS.

The total funds available for the geologic work of the Survey in the United States for the year 1914–15 were as follows:

Geologic surveys	$400,000
Statutory salaries	13,700
Search for potash deposits (part of the appropriation for chemistry and physics)	16,150
	429,850

The allotments of the appropriations were as follows:

Section of eastern areal geology	$24,700
Section of western areal geology	47,700
Section of Coastal Plain investigations	12,400
Section of glacial geology	7,175
Section of paleontology and stratigraphy	23,500
Section of metalliferous deposits	47,855
Section of nonmetalliferous deposits (including potash)	38,750
Section of eastern fuels	31,800
Section of western fuels	57,610
Geologic map editing	7,020
Débris investigation and inspection	4,400
Supervision, administration, salaries of clerical, technical, and skilled labor forces, instruments, supplies, and contingent fund	95,440
	398,350
Land-classification board	31,500

Of the amounts allotted to this division, approximately $309,900 was expended directly for geologic work, including the search for potash. Of this amount, about $208,540, or 67.3 per cent, was expended west of the one-hundredth meridian and $101,375, or 32.7 per cent, east of the one-hundredth meridian. If, however, the $31,500 for the operations of the land-classification board is included, 70.3 per cent of a total approximating $341,415 was spent for investigations west of the one-hundredth meridian—that is, essentially in the public-land States. The allotment for supervision, etc., is divisible in very nearly the same proportions between the eastern and western work.

COOPERATION WITH FEDERAL BUREAUS AND STATE SURVEYS.

In strictly geologic field investigations or paleontologic studies the Survey cooperated through the division of geology with 17 States—Georgia, Illinois, Iowa, Kentucky, Maryland, Michigan, Minnesota, Mississippi, Missouri, New Jersey, North Dakota, Oklahoma, Oregon, Pennsylvania, Tennessee, Virginia, and Wisconsin. Informal cooperation, without specific financial obligations, exists between most of the other States having geological surveys.

The Survey cooperates with the Bureau of Mines in the metallographic study of ores, in the investigation of the invasion of California oil wells by salt water, in studies of the application of geology to engineering problems of mining and construction, and in the examination of placers and placer mining in the United States. The Survey is also engaged with the Bureau of Standards, the Bureau of Mines, and the Office of Public Roads in a thorough and systematic study of the building stones of the United States. Through the division of geology it also cooperated informally with the Smithsonian Institution, the Bureau of Fisheries, the Forest Service, the Navy Department, the War Department, and the Lighthouse Service, as well as with a number of institutions of learning, including, in particular, the Geophysical Laboratory and Marine Biological Station of the Carnegie Institution. Services varying in extent have, during the year, been rendered to the Department of Agriculture in the examination of lands in the national forests; to the Department of Justice in connection with its suits regarding public lands; to the Navy Department in regard to oil and water supplies; to the Office of Indian Affairs in the classification of Indian lands in Arizona, Washington, New Mexico, and Oklahoma; to the War Department with reference to water supplies in its reservations; and, most important of all, to the General Land Office in the classification of withdrawn coal, oil, and phosphate lands.

The geologic work of the division, both in the field and in the office, is under the immediate supervision of the chiefs of the respective sections, who are directly responsible for maintaining efficiency and a high standard of work. Exceptions are made of the studies of detrital deposition in California, completed by G. K. Gilbert under the joint auspices of the geologic and water-resources branches, the general descriptions by Mr. Gilbert of the structure in the Great Basin region, and the general monographic description of the geology of the Yellowstone National Park, in preparation by Arnold Hague. The work of these distinguished senior geologists of the Survey is reported directly to the chief geologist.

GENERAL FEATURES OF THE WORK OF THE YEAR.

The more important scientific and economic investigations in progress in the division of geology were briefly described in the report for last year, pages 34–36, 71–74; this year reference will be made only to those features of the work that may be either new or noteworthy as to progress, as to changed conditions, or as to policy.

The most important item affecting the work of the geologic branch during the year was the increase in the appropriation for geologic surveys from $300,000 to $400,000. This was a net addition of but $65,000 to the funds of the branch, however, for $35,000 of the new appropriation was required merely to replace the amount which, for several years, had been contributed by the General Land Office to the cost of the Survey work in the classification of the public lands. The net gain in available funds has been used to enlarge the operations of all sections; but the largest proportion, in accordance with the understood spirit of Congress in voting this increase, has been devoted to the classification and valuation of lands in the public domain.

In the search for potash no clue has been neglected. In accordance with plans made the previous year, a deep well was drilled in the season of 1914 near the center of the Black Rock Desert, in western Humboldt County, Nev. Because of the late date (August 1) on which the appropriation bill was passed, the beginning of work was much delayed. However, when once started, the drilling was remarkably free from delay or mishap and on November 16 was completed to a depth of 1,500 feet. The cost of the work as carried out by the Survey with its own equipment was far less than the amount named in the lowest of the bids received for it, all of which were rejected. No bed of potash or other salts, in massive form, was encountered in this well. Nevertheless, the test is not considered conclusive as to the hypothesis that buried saline deposits remain in some of these basins as the result of the drying up of the lakes of Nevada, eastern California, and southern Oregon in Quaternary time. The field to be explored is large, and both the funds and the facilities for exploration have limited the trials to a few localities. The hypothesis on which this exploration, which is in charge of H. S. Gale, has been based deserves further test in the hope that potash-rich salt muds or brines, similar to or more concentrated than those found at Searles Lake, Cal., may be found in other places. In connection with this drilling a study of the sediments composing the beds penetrated by the drill, by the use of the microscope and soil analyses, was begun by M. I. Goldman in order to procure information as to the climatic and other conditions prevailing at different times during the long period in which the lake basin was being filled and converted into a desert. All drill samples containing salts in appreciable quantities were subjected to chemical tests.

The geologic formations which, from the evidence in hand, are regarded as more likely than others to contain buried potash salts in commercial amounts are the Quaternary lake beds in the Great Basin region of the West and the Permo-Triassic red beds of the Rocky Mountain States, Kansas, Oklahoma, and Texas. Whether or not the Quaternary lake province is the one which contains the larger potash-bearing deposits, it would at least appear that the centers of desiccation can be more readily as well as more accurately located in that province and that the drilling adequate for testing can therefore be accomplished with better data for guidance as to locations, with a comparatively small number of deep holes, and at far less cost. The results of exploratory boring in Searles Lake and the shallowly buried salt beds in Death Valley, Cal., establish a degree of validity for the Quaternary lake basin hypothesis and certainly encourage testing in other basins, though it is, of course, quite possible that, on account of geologic conditions not to be detected at the surface of the ground, no other deposits of importance may be present in any other basins. Certain of the basins may safely be condemned on the physiographic and geologic evidence, but beyond the limits of geologic interpretation the question can be determined only by patient search with the drill. A new drilling outfit, specially designed for the work, was purchased in the spring of 1915, supplies were ordered, and other preparations made for drilling at the beginning of the new fiscal year, at localities already selected by Mr. Gale in the Smoke Creek Desert, Nev., which will next be tested.

Studies of the red beds have been carried on in Wyoming, Colorado, Arizona, and New Mexico, in order to define as nearly as possible the basins of sedimentation in Permo-Triassic time and so indirectly, if not directly, to locate the centers of extensive desiccation of the red-bed areas. That there has been desiccation on a great scale in these regions is shown by thick deposits of salt and gypsum in the red beds over large areas. Search is being made for the basins and portions of basins in which saline deposits are the most numerous, as well as thickest, and in which, especially, there may be evidence of the complete drying out of the sea. Samples are gathered, wherever conditions are suitable, for testing in the laboratory. In June the field examinations of the red-bed outcrops in eastern New Mexico was resumed by N. H. Darton, one of the geologists most familiar with the stratigraphy of these formations.

Hope for the discovery of potash deposits in the red beds of the Southwest is encouraged by the detection of slight potash indications in the west-central region and in the Panhandle of Texas. The first of these reported indications was noted at Spurr, in Dickens County, Tex., by Dr. J. A. Udden, of the bureau of economic geology and technology in the University of Texas, while examining the records and drillings of wells in the Paleozoic regions of Texas, as special agent of this Survey. Subsequent drilling in the region has been investigated, with the discovery of additional traces of potash in the Panhandle, not far from Amarillo, by the State University bureau under the direction of Dr. William B. Phillips.

Evidence warranting boring especially for potash salts by the Government, if not by private parties, at some point in the red-bed region may at any time result either from the geologic examinations now in progress or, as is possibly more likely, from the chance discovery of potash indications or even of a valuable deposit in some well drilled for oil or water. The red beds are very extensive, covering portions of several States in a continuous formation. Pending the conclusions drawn from the geologic studies as to the probable centers of greatest saline deposition in this region, there may be little choice of location throughout large areas. Consequently random locations in untested areas by drillers for oil, gas, or water probably offer, if the drilling is properly conducted with adequate scientific observation, collection of cuttings and brines, and chemical analyses, as good chances for the discovery of potash salts as drill holes located by the Government in advance of the geologic studies. Hence every effort is made to cooperate with all drillers who may be boring in the regions which are under examination or which it is thought may contain large saline deposits. Sample bags and specially prepared log books are furnished to them with the request that cuttings be taken from every "screw," at least in the regions of the formations containing or adjacent to the saline or gypseous deposits. Also samples of brines are solicited. All these samples are tested for potash in the laboratory of the Survey, and the drillers are informed as to whether potash is present in considerable amounts in any of the samples. In the lack of funds sufficient to carry on the exploration more rapidly and especially to conduct boring operations in several areas at once, the effort will be made, whenever possible, to station scientific observers at the sites of new drillings in areas which would appear to be especially promising or in which indications have been reported, in order that the cuttings of the drill may be watched on the ground by a competent observer and tests made of the samples and brines as the work progresses.

It is hoped that drillers for oil and water, not only throughout the red-bed region but in the salt-bearing regions of the Salina and other formations in the Eastern States, may be interested to take advantage of the cooperation of the Geological Survey in the examination of their drill records and cuttings, in order that the possible presence of potash deposits of value in any of these regions may be recognized. In portions of the saliferous areas in the more thickly settled Eastern States such cooperation by the drillers would easily afford adequate exploration. Wildcat borings in new districts, located in unexplored depositional basins, are of particular importance, and special effort is therefore made to engage the interest of drillers at such points in the examination of their borings by the Survey. There are, however, large areas, especially in the red-bed region, in which no boring is in progress or possibly even contemplated so far as is known to the Survey. In view of the urgent need for the discovery of potash and nitrate supplies within the territory of the United States, it is greatly to be regretted that the funds available for this search are not sufficient to permit exploration on a larger scale through the employment of several drill rigs, operating at once in a number of the relatively favorable regions.

In addition to the explorations above described, the Geological Survey is testing all samples sent to it for examination from reported discoveries of potash salts or nitrates. It has also made field investigations of reported deposits concerning which the tests have been favorable, and the information submitted with the samples has warranted the hope that the deposits might prove to be of value. Many of the samples forwarded contain no potash or nitrates in notable quantities. With few exceptions the deposits have been too lean or, especially the nitrate deposits, too small, though fairly numerous, to be commercially important. A large number of wells, earths, brines, and prospects have been examined in the field, as well as in the office, and considerable attention has been given to the examination of brines from developed salt or bromine producing fields and from the salt-dome oil fields.

In many lines the geologic work of the Survey is showing marked tendency toward greater exactness of method, with corresponding greater definition of results. The exploratory, reconnaissance, and qualitative methods are gradually being supplanted by detailed examinations, and with the more general application of engineering methods the results are in larger measure quantitative. This is most apparent in the work of land classification. In the classification of coal lands, as described in Bulletin 537, the determinations of geologic boundaries of outcrops of coal beds, and of key rocks, as to geographic position, dip, and elevation, are made instrumentally. The economically valuable beds are more frequently prospected and sampled, their variability and continuity are more systematically noted or calculated, and, finally, depths, tonnage, and values are computed. Comparable methods are now employed also in the survey of iron deposits, the examinations for possible oil pools, and the classification of phosphate lands. Gradually and systematically data are being gathered in the different regions for a tonnage estimate of the wealth of the United States in calcium phosphate. The problem of exploiting, manufacturing, and marketing this priceless endowment of phosphate in such ways as will lead to its larger use by the American farmer is worthy of the most serious consideration. It is an economic misfortune and a reproach that so large a proportion of the phosphate rock (35 per cent of the total production of 2,734,043 tons in 1914) now mined in this country is shipped abroad to enrich the soils of foreign countries while the soils of the United States are in general becoming slowly impoverished. With a rapidly increasing urban population to be fed, we are confronted by a waning crop production to the acre, and, in the end, by an adverse balance of foreign trade that must be met by a gradual sacrifice of our unreplaceable mineral resources, either in manufactured forms or in the raw state, instead of by products of the soil that may be renewed without exhaustion of the source.

To supply the need for general information, accurate though condensed, as to the coal fields of the country, descriptive summaries, with maps, similar in some respects to those published in the Twenty-second Annual Report of this Survey, are being prepared for issue as parts of a general report on the coal fields of the United States, under the supervision of M. R. Campbell. In this report, for which there is a constant and large demand, the coal resources of the many fields will be differentiated and, with additional and more precise data than have hitherto been available, will be recalculated quantitatively in revision of the estimates by Mr. Campbell printed in Mineral Resources for 1907 and of those later prepared by the Survey for publication in "Coal resources of the world," under the auspices of the International Geological Congress which met in Toronto, Canada, in 1913.

Comparable in some respects to the engineering and quantitative methods of investigation applied to some of the nonmetalliferous and fuel deposits is the systematic study of the metalliferous deposits by natural provinces or by large geographic units, such as States. Comprehensive and systematic studies like those of the mining districts of Utah, by B. S. Butler, or of Idaho, by J. B. Umpleby, both now in progress under the direction of F. L. Ransome, can not fail to give a better knowledge of the general conditions of occurrence and modes of association of the different ores, the origin and characteristics of the deposits, and their limitations and adaptations with reference to different treatments. Nevertheless, such more comprehensive investigations can not relieve the Survey of the necessity for reconnaissance examinations of newly discovered or newly developing districts and for the special study of the geology of deposits which present new or unusual features and of those which, though not now valuable, may hereafter become so.

The progress of knowledge as to the origin of metalliferous deposits, a line of early geologic inquiry, is marked possibly more strongly than ever by a broadening of the methods of investigation. This is shown in the increasing diversity of the researches in geology, chemistry, and physics contributory to the solution of the problem. The studies of the enrichment of ore deposits demand, among other things, the understanding of paleogeographic conditions, the interpretation of geologic history, and the paleontologic determination of the time elements concerned. More observations must be made of the influence of various minerals on the deposition of metals, such as silver, or of other minerals, from solution, as is shown by E. S. Bastin and Chase Palmer in their studies of silver enrichment. Further, the metallographic microscope, with its photographic attachment, supplements the petrologic microscope and chemical methods in the differentiation of the opaque minerals and the study of their mode of association and their origin. By this means supposed chemical compounds have been shown to be mere mixtures of minerals, and relations previously unsuspected or unproved have been discovered. Inasmuch as the metallographic study of the relations and mode of association of the individual minerals in composite ores promises to give aid in separating and reducing such ores, as well as in solving the problems regarding the origin of the ores, this study is recognized as of direct and mutual concern both to the Geological Survey and to the Bureau of Mines. Accordingly, the work of F. B. Laney is carried on under the joint auspices of the two bureaus. That part of the investigation which concerns the genesis of the ores and their deposition falls naturally within the province of the Geological Survey, while the application of the ascertained facts concerning the genesis of the ore minerals, their association in the rock, and their mechanical differentiation is to be made by the Bureau of Mines in the solution of problems of successful treatment and utilization. In these studies biochemistry also must be considered, as it is in the study of the deposition of iron oxide by E. C. Harder.

Another inquiry that may have far-reaching significance with reference to the occurrence and relations of metals and other substances as now found in the earth is illustrated by the experiments made by C. E. Van Orstrand on the diffusion of solids, which are more fully mentioned in the account of the work of the division of chemistry and physics.

Recognizing that the ability to form a correct judgment as to the practical utilization and value of an ore or other mineral deposit in the ground is most effectively acquired through the field observation of operating works and processes for the exploitation and reduction of the same or similar deposits, the Survey regards it of the highest importance that the geologist who may be called upon to appraise undeveloped mineral resources in the public domain or in other regions of the country shall keep as closely as practicable in touch with the mineral industry, and shall have a knowledge of the factors conditioning the successful treatment and utilization of the ores he is examining. In the acquisition of this necessary special knowledge of mineral deposits of a certain type and of the industry based on that type, the record of the production of that industry is, so to speak, a by-product of the estimate of the deposits and the study of the processes. Accordingly, it is found not only that the reports of mineral production in the United States can be most satisfactorily as well as economically prepared by the geologist who has specialized in the particular lines of economic geology, but also that the geologist becomes thereby better qualified for his field investigations and for service to the increasing number of applicants to the Survey for data, otherwise not obtainable, concerning ore deposits and their utilization, the marketing of ores, or the obtainment of minerals or mined products. It thus happens that the geologist may be reporting the mineral production on the one hand, while he may at the same time on the other hand be taking, perhaps on a quantitative basis, a census of the country's undeveloped reserves.

The great damage to certain oil fields, especially in California, through the entrance of water into the oil-producing sands, with the result that large quantities of oil can never be extracted, has made it necessary for the Government, as one of the large landholders in the region, to take part in the investigation of the causes and in the means for prevention. Accordingly, late in the fiscal year 1914 the Bureau of Mines and the Geological Survey jointly undertook the examination of the problem, in which the Survey has been studying the conditions of the association of water, oil, and gas in the sands, and their modes of migration with special special reference to the mechanical constitution, chemical composition, and attitude of the beds. The methods of remedying the evil and the engineering devices for conserving the oil are receiving consideration from the Bureau of Mines. The investigations conducted by the Survey are far reaching, touching even the problems of the origin of oil and gas, and may not be concluded without prolonged studies in many fields; but all the oil and gas geologists of the Survey are deeply interested in the inquiry, and it is certain that their combined researches will lead to a better understanding of the laws of the occurrence and movements of oil. Meanwhile the data relating immediately to the causes of the local damage in California are being assembled in the form of a report.

The general reconnaissance survey of the geologic formations, paleontology, and underground-water supplies of the Atlantic and

Gulf Coastal Plain has reached an advanced stage. This work, which has for a number of years been in progress under the direction of T. Wayland Vaughan, has, quite aside from its important economic products, contributed in a most invaluable way to the knowledge of the stratigraphy and geologic history, not only of this great area of the United States but of all southern North America and Central America. A part of the general problem now receiving much attention concerns the correlation of the Pleistocene terraces from region to region and from the Coastal Plain into the glaciated regions, in the effort to connect, so far as possible, the Quaternary history and physiography of the Coastal Plain regions with the glacial stages and deposits to the north.

Conclusions that are essentially by-products of the main investigations just cited are illustrated by the results of Mr. Vaughan's researches regarding the coral-reef plateaus and the continental shelf in the Antillean region and the origin of oolites and calcareous deposits, or of the studies by E. W. Shaw of the fluviatile and estuarine deposition of sediments. Investigations like Mr. Shaw's are immediately applicable to such studies as the examination of the borings made in the course of potash exploration in Nevada.

Looking forward to the day when the oil and gas resources of the United States will have become depleted, the Geological Survey is giving some attention to the carbonaceous shales of the United States and their capacity to yield petroleum, gas, and other valuable distillates. The examinations of the hydrocarbon shales in the Green River formations of Colorado and Utah are described on page 61, and preliminary statements of the results of the investigations will be published at an early date. Some experimental tests have also been made of the carbonaceous shales of Devonian age in the Eastern States and of the cannel coals and the richly carbonaceous shales associated with other coals in these States. Field tests are made by a portable apparatus carried from camp to camp. The laboratory distillations and fractional separations are performed by the Bureau of Mines.

The most important of the new cooperative projects organized within the year is that for the comprehensive study of the placer deposits of the United States. Preliminary work in accordance with this plan, which was initiated by the Geological Survey, was done by J. M. Hill, who is considering the character, geologic occurrence, and origin of the deposits. The contribution by the Bureau of Mines will relate to methods and costs of placer mining and will be made by Charles Janin, a mining engineer of that bureau. It is expected that the field work will extend over two or more field seasons.

The foregoing sketch of some of the features of the work of the division of geology that appear to be noteworthy does not include some of the most important scientific work, which is too well known to require special comment.

SCOPE OF THE WORK OF THE SECTIONS.

The work of the several sections of the division of geology is briefly outlined in the following synopsis:

1. The section of eastern areal geology—Arthur Keith, geologist in charge—conducts reconnaissance and detailed work in areal or general geology in regions east of the one-hundredth meridian, the primary object of which is to make known, mainly through folios of the Geologic Atlas, the general geology of the region studied, or to prepare scientific and educational descriptions of it, rather than to examine and describe or map the area especially on account of some geologic problem or some particular economic resource. The work of this section is carried on in close cooperation with several State surveys and university departments of geology, an effort being made to coordinate the work of all participants. During the year the operations of the section have covered areas in Alabama, Arkansas, Delaware, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Vermont, and Virginia.

2. The work of the section of western areal geology (west of the one-hundredth meridian)—F. L. Ransome, geologist in charge—corresponds to that of the section of eastern areal geology and is similar in scope, these sections being especially charged with the preparation of the folios of the Geologic Atlas of the United States.

Four geologic railway guides, designed primarily for the benefit of travelers to the Panama-Pacific Exposition, have been prepared under the general auspices of this section. Field work was begun by six geologists early in June, 1914, and was continued into the autumn. One of the four resulting bulletins (Bulletin 612) has already appeared and is described on page 27.[1] The activities of the section have concerned the States of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oklahoma, Oregon, South Dakota, Utah, and Washington.

3. The section of Coastal Plain investigations—T. Wayland Vaughan, geologist in charge—is occupied primarily with the study of the numerous geologic formations of the Atlantic and Gulf Coastal Plain, their character, extent, general structure, correlations, conditions of deposition, and geologic history, and especially of the underground-water resources of the region. Incidental attention is given to other mineral resources which are more particularly consid-

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[1] The other bulletins of this series have been published since the close of the fiscal year.

ered by other sections. Because of their importance in accurately tracing the different geologic formations and in supplying a reliable basis for geologic correlation, the fossil organisms entombed in the different formations are carefully studied. Most of the areal work of this section during the year has been of the reconnaissance type. Its office investigations are comprehensive and broadly scientific, as well as economic. The National Museum, the Bureau of Fisheries, the Carnegie Institution, and a number of specialists in biology or paleontology, as well as the division of underground waters of the water-resources branch, have cooperated with or contributed to the work of this section.

Investigations have been carried on by this section during the year in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, North Carolina, Rhode Island, South Carolina, Tennessee, Texas, and Virginia.

4. The section of glacial geology—W. C. Alden, geologist in charge—is engaged in the study of the work of glaciers, the glacial and interglacial deposits and the contemporary deposits of the bordering regions, and the geologic history of the continent during the Quaternary period. The geologists occupied with these varied and specialized problems are charged with the classification and mapping of the Quaternary deposits of the glaciated regions. The work of this section during the year has comprised field studies and mapping and the preparation of reports covering areas in Illinois, Indiana, Iowa, Massachusetts, Michigan, Minnesota, New York, North Dakota, Vermont, and Wisconsin.

5. The section of paleontology and stratigraphy—T. W. Stanton, geologist in charge—is responsible for the determination of the relative age and equivalence of the strata in different areas and for the reference of the formations to a geologic time scale. The examination of current collections of fossils and the preparation of reports on them for the use of geologists engaged in areal mapping and special investigations occupy a large proportion of the time of the paleontologists. The geologists who specialize in paleontology are engaged also in working out the sequence and character of the continental changes, the physiographic and climatic conditions of the various periods, and the history of the animal and plant life of the geologic epochs. The field study of the stratigraphic distribution of the fossil floras and faunas gives the most complete key to the correlation of the beds; hence the paleontologists can most efficiently accomplish their work by close cooperation with the areal and economic geologists. The work of this section is practically coextensive with that of the divisions of geology and of Alaskan mineral resources and is indispensable to the geologic mapping of the areas surveyed and the satisfactory determination of the structure. The States receiving most

attention from this section during the year were Alabama, Arkansas, Colorado, Florida, Georgia, Idaho, Indiana, Kentucky, Maine, Maryland, Missouri, Montana, North Dakota, Oklahoma, South Dakota, Tennessee, Virginia, Wisconsin, and Wyoming.

6. The section of metalliferous deposits—F. L. Ransome, geologist in charge—not only studies metalliferous deposits and mines and investigates the conditions and methods of ore deposition, but also carries on reconnaissance geologic examinations of many new districts and makes complete detailed areal surveys, for folio publication, of quadrangles in which metalliferous deposits are of special importance, the folios being subject to the inspection and approval of the geologists in charge of areal geology. The geologists of the section have been engaged on projects in Alabama, Arizona, California, Colorado, Georgia, Idaho, Kansas, Louisiana, Minnesota, Missouri, Montana, Nevada, New Mexico, Oklahoma, Oregon, Tennessee, Texas, Utah, Washington, and Wyoming.

7. The section of nonmetalliferous deposits—Hoyt S. Gale, geologist in charge—is concerned with the study of the deposits of nonmetallic ores and minerals, exclusive of fuels, and with the geologic investigation and mapping of regions in which such minerals or deposits are of paramount importance. During the year the greater part of the work of the section has been divided between the search for potash in commercial quantities in the salts of the old evaporation basins or dried-up ancient lakes of the Southwest and the classification of the phosphate-bearing lands withdrawn from entry in Idaho and Wyoming. Special investigations relating to clays, building stones, the eastern phosphate fields, and mica have also been carried on. The work in this section relates in particular to Alabama, California, Colorado, Connecticut, Georgia, Idaho, Kentucky, Massachusetts, Maryland, Minnesota, Nevada, New Hampshire, New Mexico, New York, North Carolina, Ohio, Oregon, Tennessee, Texas, Utah, Virginia, West Virginia, and Wyoming.

8. The section of eastern fuels—David White, geologist in charge—conducts examinations of areas east of the one-hundredth meridian containing coal, oil, or gas. It not only investigates and describes the economic geology, but in some regions also works out the detailed areal geology for folio publication, the folios being subject to the inspection and approval of the geologist in charge of the section of eastern areal geology. The work of the section during the year has been conducted in cooperation with the State surveys of Illinois, Missouri, Minnesota, Oklahoma, Pennsylvania, Tennessee, and Virginia. Noncooperative work has been done in Arkansas, Georgia, Indiana, Iowa, Kansas, Louisiana, Mississippi, Ohio, Texas, and West Virginia.

9. The section of western fuels—M. R. Campbell, geologist in charge—conducts examinations and surveys in the fuel-bearing areas west of the one-hundredth meridian similar to those carried on by the section of eastern fuels. The greater part of the work of the western section has consisted in classifying and mapping coal or oil bearing lands of the public domain in California, Colorado, Montana, New Mexico, North Dakota, Oregon, Utah, and Wyoming, but a part of the work in this section was done in quadrangle units for folio publication, subject to the approval of the geologist in charge of the section of western areal geology.

The section of geologic-map editing—G. W. Stose, geologist in charge—is a part of the publication branch, but its work is so intimately associated with the work of the individual geologists in the division of geology that it is administered as a part of the geologic branch, in which the chief of the section is an active geologist. The geologic field investigations made by Mr. Stose are reported in the work of the sections to which they pertain.

ASSISTANCE TO OTHER DIVISIONS.

In addition to performing work in their respective sections, a considerable number of the geologists in the sections of metalliferous and nonmetalliferous deposits and several geologists in the sections of eastern and western areal geology have prepared for publication, in the annual volumes of Mineral Resources, reports on the production and statements of the industrial conditions relating to a large number of mineral resources with which they are especially familiar. Parts of the salaries of some of these geologists are paid from the funds of the division of mineral resources, and the traveling and field expenses incurred by others in the collection of data are also paid from the funds of that division.

A number of economic geologists of this division serve as members of the special committees of the land-classification board. The paleontologists of the division report on fossils collected for the division of Alaskan mineral resources and are called upon to classify fossils for the National Museum and, through courtesy, occasionally for foreign governments and other scientific institutions.

Close cooperation, with constant interchange of information, exists between the geologic branch and the water-resources branch in the investigation of underground-water movements and supplies and of sedimentary deposition. Members of the land-classification board serve in the geologic field parties.

COMMITTEE ON GEOLOGIC NAMES.

The committee on geologic names is a standing committee of the geologic branch, consisting of T. W. Stanton (chairman), M. R. Campbell (vice chairman), W. C. Alden, G. H. Ashley, Arthur Keith, F. L.

Ransome, G. W. Stose, and David White. The minutes and other records are kept by the secretary, Miss M. G. Wilmarth, who also scrutinizes the geologic nomenclature and classification used in all manuscripts submitted for publication and prepares data on them for consideration by the committee. During the year 175 manuscripts, comprising 19,425 pages and involving about 3,643 geologic names, have been examined.

To meet the needs of the Survey geologists, as well as a strong demand from professional geologists in general, the work of compiling correlation charts and a stratigraphic lexicon of geologic formations in the United States and Alaska, in form for publication as bulletins, has been begun. The committee has invited the advice and cooperation of over 200 American geologists in the consideration of general questions relating to the revision of the classification and the nomenclature of North American geologic formations.

GENERAL SUMMARY.

Geologic investigations were continued in 47 States by a force of 164 geologists. Systematic detailed surveys of mining districts were carried on in Arizona, Colorado, Minnesota, Nevada, New Mexico, Oklahoma, Oregon, and Utah. Reconnaissance studies of mining districts were made in Arizona, California, Colorado, Idaho, Kentucky, Montana, Nevada, New Mexico, North Carolina, Oregon, Tennessee, Utah, and Wyoming, and general and detailed geologic and paleontologic work was continued in all parts of the country, including a large amount of geologic work in the coal and oil fields, especially in the public-land States, where also the search for commercial deposits of potash and nitrates was continued. Cooperative geologic work was carried on with the State geological surveys of 17 States, also with the Bureau of Mines, Bureau of Standards, Office of Public Roads, Bureau of Fisheries, Forest Service, Smithsonian Institution, Lighthouse Service, Geophysical Laboratory of the Carnegie Institution and the marine biologic station at Dry Tortugas.

Among the geologic investigations not relating to any particular region mention may be made (1) of the extension of the studies of sulphide enrichment, by W. H. Emmons, who has submitted a revised and greatly enlarged text replacing Bulletin 529 on this subject; and (2) of the investigation by David White into the origin of coal and petroleum and the development of the different classes of these fuels. The origin and the conditions of occurrence of oils of successively higher grades, and some conditions precluding the occurrence of oils in different regions are discussed in an address by Mr. White before the Washington Academy of Sciences and printed in the Journal of the Academy for March 19. A general paper on the origin of coal, prepared by Mr. White several years ago for publication by the Bureau of Mines, has been printed in Bulletin 38 of that bureau.

WORK OF THE DIVISION BY STATES AND COUNTRIES.

The work of the division of geology during the year was done in 47 States, the Canal Zone, the Antilles, and the Hawaiian Islands.

ALABAMA.

The upper Eocene and Oligocene formations of Alabama have been thoroughly studied by C. Wythe Cooke, whose stratigraphic correlations have been transmitted for publication by the Survey as Professional Paper 95–I, "The age of the Ocala limestone." Mr. Cooke has in preparation also a preliminary account of the stratigraphy of the St. Stephens limestone.

Two manuscripts, one on the Catahoula formation and the other on the Pliocene of the Gulf Coastal Plain, have been submitted by G. C. Matson and E. W. Berry, Mr. Matson writing the stratigraphic descriptions and Mr. Berry the paleontologic descriptions and correlations, based on the study of the fossil plants. Mr. Berry has in preparation also a report on the fossil flora of the Claiborne group.

For the better definition and correlation of several of the formations to be described and mapped in the Bessemer-Vandiver and Montevallo-Columbiana folios, additional field examinations were made by Charles Butts, partly in conference with E. O. Ulrich, in the vicinity of Pelham and in the Shades Valley southeast of Bessemer. Paleontologic data for correlations in other regions of the State were collected by R. D. Mesler from the earlier Paleozoic formations.

In accordance with an informal cooperative agreement between the State geologists of a number of the Mississippi Valley States and the Federal Survey for the purpose of better differentiating the Mississippian formations and establishing correlations between different regions of the Mississippi, Ohio, Tennessee, and Appalachian valleys, the Carboniferous rocks of the Mississippian section near Huntsville were studied by G. H. Girty, with the object of collecting invertebrate fossils and making correlations.

The mica deposits in Randolph, Clay, Tallapoosa, and Coosa counties were examined by D. B. Sterrett, who has nearly completed the field work for a report on mica in Alabama.

A little field work was done on the red iron ores of northeastern Alabama by E. F. Burchard.

ARIZONA.

The quicksilver deposits of the Mazatzal Mountains, covering an area of about 20 square miles, were examined by F. L. Ransome, who submitted a brief report thereon (Bulletin 620–F). Mr. Ransome also made a geologic reconnaissance of the Sierra Ancha and paid short visits to the Ray and Miami mining districts for the purpose of collecting supplementary specimens and data for his economic report on these districts. A brief paper on the Paleozoic section in the Ray quadrangle was published by Mr. Ransome in an unofficial periodical.

A report on the mineral deposits of the Santa Rita and Patagonia Mountains by F. C. Schrader was published as Bulletin 582.

A detailed examination of the Colorado River and Yuma Indian reservations, primarily for purposes of classification, was made at the request of the Office of Indian Affairs. Some of the results of this work, which was done by E. L. Jones, jr., were embodied in a paper on the placer deposits near Quartzsite (Bulletin 620–C). Mr. Jones also prepared a brief report on a reconnaissance covering perhaps 60 square miles in the Kofa Mountains (Bulletin 620–H) and has in preparation a short report on the Dos Cabezas mining district, the field work for which was done during the previous season. A preliminary draft of the Tucson folio, on which C. F. Tolman, jr., has been engaged, was submitted by him, but further field work is necessary before the text and maps will be ready for publication.

A report on the Shinumo quadrangle, in the Grand Canyon district, by L. F. Noble, appeared as Bulletin 549. Further studies of Grand Canyon geology are being prosecuted by Mr. Noble, chiefly at his own expense.

The detailed areal and economic survey of the geology of the Winkelman quadrangle has been begun by C. H. Clapp, who has mapped 173 square miles.

A reconnaissance report on northeastern Arizona and northwestern New Mexico, based on several years of field examinations by H. E. Gregory, has been nearly completed. Field work in this region is now in progress.

In connection with the preparation of the guidebook to the region along the Santa Fe Route, from Kansas City to Los Angeles, field examinations were made at a number of points in Arizona.

At the request of the Department of Agriculture an examination of some mining claims in the Grand Canyon was made by H. G. Ferguson, whose preliminary report has been transmitted to the Secretary of the Interior.

ARKANSAS.

A study of the recent geologic history in the vicinity of Moon Lake for the Department of Justice, by E. W. Shaw, has resulted in interesting observations on the processes and effects of erosion and sedimentation, which will be incorporated in Mr. Shaw's report on the Mississippi embayment.

The fossil floras of the Jackson and Claiborne groups in Arkansas are now being studied by E. W. Berry. The results of this work will be important not only in correlations between other areas and Arkansas but in contributing to knowledge of the extinct floras of the earlier Tertiary in southern North America.

Short examinations, necessary for the correlation of the formations of the Hot Springs, Caddo Gap, and DeQueen quadrangles, were made by H. D. Miser. The Hot Springs folio is well advanced toward completion and the manuscript for the Caddo Gap-DeQueen folio is progressing satisfactorily.

A folio covering the Harrison and Eureka Springs quadrangles was completed by H. D. Miser and A. H. Purdue and has been submitted for publication.

The gypsum deposits of Arkansas have been described by Mr. Miser for publication in the revised edition of Bulletin 223. Mr. Miser also furnished the Arkansas data for use in the revision of Bulletin 585, "Useful minerals of the United States."

Water-Supply Paper 399, "Geology and underground waters of northeastern Arkansas," by L. W. Stephenson and A. F. Crider, with a discussion of the chemical character of the water by R. B. Dole, has been revised and is now in the hands of the editor.

The asphalt deposits near Mena were examined by C. H. Wegemann. These deposits are interesting mainly because of the advanced carbonization of the hydrocarbon substance, which appears to have suffered alteration.

The Carboniferous faunas of Arkansas have been described by G. H. Girty in Bulletins 593, 595, and 598, in press at the close of the fiscal year.

CALIFORNIA.

A review of the deposits of salt, soda, borax, and potash at Searles Lake, San Bernardino County, was made by H. S. Gale, and a report on these deposits was issued as Bulletin 580–L. A brief report on the Amargosa nitrate area, in Inyo County, by Mr. Gale, was transmitted to the War Department, at whose request the examination was made.

Studies of the petroleum resources of the State were continued by R. W. Pack, G. S. Rogers, and W. A. English, and the investigation of the Sunset-Midway field was completed, special attention being given to the underground conditions as revealed by the drill records, in order to discover, if possible, the laws governing the accumulation of oil and gas and particularly the relation of productive pools to geologic structure and to water. A detailed resurvey, including about 300 square miles, was made of the areal geology in this field and the surrounding areas, the description of which, mainly by Mr. Pack, is now in preparation. Special attention was given by Mr. Rogers to the conditions of water movement and invasion. In prosecuting this work he made a close study of the geologic structure and of the history and behavior of the wells. In the determination of local structure, as well as in the consideration of the water problem, Mr. Rogers contributed to the investigation of the general geology of the region.

Ralph Arnold, formerly of this Survey, assisted by J. R. Pemberton, spent 10 days in field revision of the geologic map of the Ventura quadrangle.

A detailed examination of the stratigraphy and structure of undrilled areas in Cuyama Valley, aggregating about 400 square miles, was made by W. A. English, under the general supervision of R. W. Pack, in order to determine their probable oil prospects. A report on these areas has been prepared and submitted for publication.

A report by Robert Anderson and R. W. Pack, on the geology and oil prospects along the western border of the San Joaquin Valley north of Coalinga, is now in press as Bulletin 603.

Studies in Yosemite National Park were continued by F. E. Matthes and F. C. Calkins. Mr. Calkins mapped in detail the igneous rocks of part of the tract represented by the special map of the Yosemite Valley. Mr. Matthes continued and nearly completed the physiographic study, including the detailed mapping of the moraines, of the upper Merced basin and of some adjacent ground. Messrs. Matthes and Calkins are collaborating in a popular account of the geology of the Yosemite region, which is designed primarily to give a comprehensive and scientifically exact yet readable explanation of the sculpture of the region but deals with all aspects of the geology. Mr. Matthes writes of the general geologic history and the work of streams and glaciers, and Mr. Calkins contributes an account of the hard rocks, whose distribution greatly influences the character of the sculpture.

The results of the detailed study of the Weaverville quadrangle are in preparation by J. S. Diller and H. G. Ferguson for issue in a folio.

A report on the lode deposits of the Allegheny district by Mr. Ferguson was published as Bulletin 580–I and a paper on the pocket gold deposits of the Klamath Mountains, also by Mr. Ferguson, was prepared for unofficial publication.

Lassen Peak, which was visited in June, 1914, and again in the autumn of that year by Mr. Diller while he was gathering data for the guidebook covering the Shasta Route and Coast Line (Bulletin 614) was revisited by him in June, 1915, for the purpose of studying the phenomena of the only active volcano in the United States (exclusive of Alaska), with a view to the preparation of an educational bulletin describing and illustrating Lassen Peak, its history and present changes, and its volcanic action as a whole.

A report on the geology of the east slope of the Sierra Nevada overlooking Owens Valley has been practically completed by Adolph

Knopf, who in the summer of 1914 made a preliminary field examination of the Mother Lode district in preparation for a thorough study of that district during the season of 1915–16.

A report on some mining districts in northeastern California and northwestern Nevada (Bulletin 594), by J. M. Hill, was issued during the year.

A portion of the Rock Creek quadrangle was mapped in detail by L. F. Noble for folio publication.

An area lying between latitude 34° 30′ and the Mexican boundary has been covered by a reconnaissance examination by R. T. Hill, who, after mapping about 4,000 square miles on a scale of 1:250,000, is now preparing a report on this region.

The report on the copper deposits of Shasta County, by L. C. Graton, the preparation of which has long been postponed in consequence of Mr. Graton's resignation from the Survey, is now well advanced, though Mr. Graton expects to make additional field revision during the coming year before the report is submitted for publication.

COLORADO.

The survey of the volcanic area of the San Juan Mountains was continued by Whitman Cross, assisted by E. S. Larsen, jr., and J. Fred Hunter, jr., but in accordance with the plan adopted in 1913 to complete the study of the great volcanic complex of these mountains as speedily as possible, the work was all of reconnaissance character. Of the 1,020 square miles examined in the northeastern portion of the mountains, 650 square miles were covered in reconnaissance and 370 miles in semidetail. In the area south of Tomichi Creek and Marshall Pass and west of the San Luis Valley, in the Cochetopa and Saguache quadrangles, it was found impossible to maintain the standard of geologic mapping followed in other regions, on account of the inadequacy of the Hayden topographic map and other maps available for the delineation of geologic details. A greater measure of success was achieved in the Creede quadrangle, of which a new topographic map was available. A report covering the season's field work is in preparation by Messrs. Cross and Hunter, and Mr. Cross was also engaged on a general report on the geology of the entire San Juan area. A paper describing the pre-Cambrian rocks along Gunnison River was prepared by Mr. Hunter.

The Pleistocene deposits in the San Juan Mountains (Montrose quadrangle) were studied by W. W. Atwood, assisted by Kirtley Mather. A report by Mr. Atwood, describing an extremely interesting glacial deposit of Eocene age in southwestern Colorado, has recently been published as Professional Paper 95–B.

A detailed report on the economic geology of Gilpin County and adjacent portions of Clear Creek and Boulder counties, embracing the Central City district, by E. S. Bastin and J. M. Hill, has been transmitted for publication. A description of the ores of Gilpin County by Mr. Bastin and a paper by Mr. Bastin and Chase Palmer on the precipitative action of metallic minerals upon silver in solution have been printed in unofficial publications. Mr. Bastin also prepared a paper on the geology of the pitchblende ores of Colorado (Professional Paper 90–A).

A report on the Creede district by E. S. Larsen, jr., and W. H. Emmons is now nearing completion, that portion of the manuscript by Mr. Emmons having already been transmitted.

For the monograph on the Leadville district, in preparation by J. D. Irving, a chapter on the oxidized zinc ores has been submitted by G. F. Loughlin, and F. B. Laney is preparing a chapter on the microstructure of the ores.

Brief investigations of reported nitrate occurrences in Colorado were made by M. I. Goldman, who has reviewed in the office the somewhat voluminous literature on the subject of soil nitrates in Colorado and Utah with a view to submitting, for record and possible publication, his conclusions regarding the availability of certain soils as a commercial source of nitrates.

The description of the fossil flora of the Laramie formation in the Denver Basin is in progress by F. H. Knowlton, and a monograph covering this work and including a historical account of the Laramie problem is now nearly completed.

In northern Colorado, from Windsor and Greeley southward to Boulder, full collections representing the fauna of the Fox Hills sandstone were made by T. E. Williard and T. W. Stanton, and a preliminary study for a comparison of them with the typical Fox Hills fauna has been made by Mr. Stanton. A collection of fossil plants from the Fox Hills sandstone has been described by F. H. Knowlton.

The Ordovician section at Canon City has been reviewed by Edwin Kirk for purposes of correlation.

The detailed examination of the mineral resources of the Yampa coal field was continued in the office by E. T. Hancock, who has submitted for publication economic reports on the Meeker, Axial, and Monument Butte quadrangles. Folios covering these quadrangles are also in preparation by Mr. Hancock. A general report on the entire Yampa coal field was submitted by Mr. Hancock for inclusion in the forthcoming paper describing the coal fields of the United States. The history of a portion of Yampa River and its possible bearing on that of Green River by Mr. Hancock was published as Professional Paper 90–K. In response to numerous requests received by the Survey, further investigations of four sections of land in the Yampa coal field for the purpose of land classification, were made by Mr. Hancock.

The investigation of the oil shale in the Green River formation in northwestern Colorado and eastern Utah, which was begun by E. G. Woodruff prior to his resignation from the Survey in 1913, was continued in greater detail by D. E. Winchester, assisted by H. M. Robinson, who made a reconnaissance examination of about 1,000 square miles. In the course of this work the oil shale beds were examined at a number of places in western Colorado, many sections were measured in detail, and numerous samples, cut from different parts of the beds, were collected and subjected to distillation tests in the field. Many samples were also shipped to Washington, where distillation tests were made in the laboratory of the Bureau of Mines by Mr. Winchester under the direction of David T. Day. The field distillation experiments were observed for a short time by Dr. Day, who, together with C. A. Davis, D. E. Winchester, and David White, revisited the De Beque region, where oil shale of unusual interest was discovered by Mr. Woodruff the previous year. Field surveys were resumed by Mr. Winchester in June, 1915, with the intention of extending the examination northward into Wyoming. A report covering the investigations of the year was completed by Mr. Winchester and submitted for publication as a chapter in Bulletin 621. In the course of brief field studies of the deposition of the oil shale at a number of points, C. A. Davis, in company with David White, collected samples of the shale and began a paleontologic investigation of its origin and composition. The oil shale was found to be composed in large part of plant remains of low orders, mainly algæ and fungi. A collection of the oil shales of Colorado, Utah, and other States, arranged by Mr. Winchester, is now on exhibition at the Panama-Pacific Exposition.

The detailed investigation of the areal and economic geology and the classification of the lands in the Red Mesa and Soda Canyon quadrangles, begun by M. A. Pishel, who resigned from the Survey in August, 1914, was continued by A. J. Collier, assisted by O. B. Hopkins. Together they surveyed 238 square miles, in which geologic mapping was done and coal outcrops were located by plane-table methods. The land has been classified, and an economic report and a folio are in preparation by Mr. Collier, who is also preparing a popular geologic guide to the Mesa Verde National Park. Mr. Collier also examined in detail the northern part of the plateau north of the Red Mesa quadrangle, in T. 35 N., Rs. 12 and 13 W., comprising an area of about 16 square miles, for the purpose of classifying and valuing the land. An economic report on this area was prepared for publication.

In the Trinidad field, near Cokedale, examinations were made by M. W. Ball for the purpose of classifying and valuing the coal lands, the report to be prepared at a later date.

In the vicinity of Austin, in Delta County, an area of about 10 square miles, including a structural dome, was hastily examined by M. R. Campbell, for the purpose of determining whether or not the geologic conditions are favorable for the occurrence of oil or gas. The conclusions, which were unfavorable, were issued in the form of a press notice for the benefit of those interested in the region. Mr. Campbell also examined a half section of coal land in the vicinity of Mattison, Elbert County, to collect data for its classification and valuation.

A report on the coal resources of North Park, by A. L. Beekly, has been published as Bulletin 596.

CONNECTICUT.

The feldspar quarries in Middlesex County, Conn., in which mica and the gem minerals tourmaline, beryl, and lepidolite are found, and the old mica, feldspar, and beryl mine near New Milford, in Litchfield County, were examined by D. B. Sterrett.

DELAWARE.

The manuscript and maps describing the areal and economic geology of the Elkton and Wilmington quadrangles, in Pennsylvania and Delaware, have been submitted by Miss Florence Bascom and B. L. Miller, for publication as a folio. The small gas emissions coming from a number of shallow-water wells near the State boundary in the region of Salisbury, Md., were investigated by G. C. Matson. (See Maryland, p. 68.)

FLORIDA.

The stratigraphic and paleontologic investigations of the upper Eocene and Oligocene formations of Florida were continued by C. Wythe Cooke, who made a special study, for correlation, of the Ocala limestone and prepared a paper on the age of that formation.

At Laurel Hill and River Junction field conferences were held by T. Wayland Vaughan with Mr. Cooke and W. C. Mansfield, and data were gathered by Mr. Cooke on the structure of the Apalachicola group by running lines of levels in both areas. The Eocene and Oligocene formations at Marianna and Chipley and the Miocene at Redbay were restudied. Mr. Cooke also made a study of the upper Oligocene and Miocene formations on Apalachicola River between River Junction and Blountstown and on Chipola River. A report on the fossil mollusks of Chipola Oak Grove and Shoal River is in preparation by Miss Julia Gardner, and two reports on the Miocene and Pliocene foraminifers of the Coastal Plain, including Florida, by Joseph A. Cushman, have been transmitted for publication.

Investigations of the Florida Keys region were continued by T. Wayland Vaughan, who prepared and published several scientific papers on the geology and recent deposits of this part of the coast.

A report on the phosphate deposits of Florida (Bulletin 604) by G. C. Matson, is in press and "A monograph of the molluscan fauna of the *Orthaulax pugnax* zone of the Oligocene of Tampa, Fla.," by William H. Dall, was published by the United States National Museum.

GEORGIA.

In continuance of the studies of the stratigraphy and paleontology of the upper Eocene and Oligocene formations in Georgia the Ocala and Chattahoochee formations at Bainbridge and vicinity were examined by C. Wythe Cooke, assisted by W. C. Mansfield. Instrumental level lines were run over the principal sections. The correlative results of the study are contained in the paper by Mr. Cooke on the age of the Ocala limestone already mentioned. A fauna at the base of the Chattahoochee formation, because of its wide geographic distribution in the Greater and Lesser Antilles, is being described by W. H. Dall.

A report of the fossil flora of the Claiborne group is in preparation by E. W. Berry.

The paper on "Underground water resources of the Coastal Plain of Georgia" (Water-Supply Paper 341), by L. W. Stephenson and J. O. Veatch, was published during the year.

Mica prospects in Hall and Cherokee counties were examined by D. B. Sterrett.

New openings on the red iron ore beds in Walker County were examined by E. F. Burchard.

IDAHO.

Studies which are to result in a comprehensive summary report on the ore deposits of Idaho, by J. B. Umpleby, were continued during the year. No field work was done, but a large amount of material previously collected was elaborated and prepared for publication. A report on the Mackay region, which embraces the drainage areas of Little and Big Lost rivers and Birch Creek, was transmitted by Mr. Umpleby for publication as a professional paper. He also finished a short paper on the ore deposits of the Sawtooth quadrangle (Bulletin 580–K) and has completed the description of the ore deposits in the Hailey quadrangle, the geology of which has been mapped for folio publication by L. G. Westgate, assisted by R. S. Knappen. Edwin Kirk, paleontologist, gave assistance in the solution of the stratigraphic problems of the area. In response to a request from the Office of Indian Affairs, Mr. Umpleby examined and reported on leakages near the head of the Blackfoot Reservoir.

The gravels of the Fort Hall bottoms on Snake River were, at the request of the Office of Indian Affairs, investigated by J. M. Hill, who submitted a paper on gold in the Snake River gravels for publication (Bulletin 620–J).

The geologic mapping of the Wayan quadrangle, which includes the Crow Creek, Slug Creek, Lance Creek, and Freedom 15-minute quadrangles, was completed by G. R. Mansfield, assisted by E. L. Jones, jr., P. V. Roundy, and E. H. Finch. Progress has been made by Mr. Mansfield in the preparation of folios for the Wayan and Montpelier quadrangles, and a paper on the geology of the Fort Hall Reservation was prepared for unofficial publication by Mr. Mansfield, who, with E. S. Larsen, jr., is unofficially publishing a paper describing the occurrence of nepheline basalt in the Fort Hall Reservation. The Paleozoic and Triassic formations and faunas of the Wayan quadrangle were studied both in the field and in the office by G. H. Girty.

For the Henry district land-classification data were completed and transmitted, and a report on the economic geology of the district was begun by Mr. Mansfield, who has also submitted a manuscript on the geology and phosphate deposits of the Fort Hall Indian Reservation. A detailed examination for phosphate in part of the Crow Creek and Freedom quadrangles was made in order to classify the lands.

Reported deposits of nitrates in the vicinity of Homedale, Owyhee County, were examined by Mr. Mansfield, whose report "Nitrate deposits in southern Idaho," has been issued as Bulletin 620–B.

A report on a geologic reconnaissance in southeastern Idaho and western Wyoming, with special reference to phosphate deposits, was submitted by A. R. Schultz.

A report classifying the lands in the vicinity of Orofino Creek and Clearwater River, examined in 1913, was prepared by C. T. Lupton, who also submitted a manuscript for a paper on the Orofino coal field for publication (Bulletin 621–I).

A summary report on the coal fields of Idaho, based on work of previous years, was prepared by C. F. Bowen for publication in the paper dealing with the coal fields of the United States, which is being compiled under the direction of M. R. Campbell.

ILLINOIS.

Under the arrangement for cooperation with the Illinois Geological Survey, the areal geology and mineral resources of the Mount Olive and Gillespie quadrangles were mapped in detail by Wallace Lee, who prepared an economic report describing the coal resources, oil prospects, and geologic structure for publication by the State geological survey, and who has brought a folio covering these quadrangles to an advanced stage. In the mapping of the glacial and associated deposits Mr. Lee conferred with W. C. Alden and E. W. Shaw. The investigation of the stratigraphy and the mapping of the areal geology in the Equality and Shawneetown quadrangles, also cooperative, was begun by Mr. Lee, and he examined portions of the Golconda and Fords Ferry quadrangles, on the Illinois side of Ohio River.

The glacial and associated deposits in the Edgington, Milan, Canton, Colchester, Macomb, Tallula, and Springfield quadrangles were briefly studied by W. C. Alden for comparison with similar deposits in Iowa.

The dark shale and bony coal overlying the Springfield (No. 5) coal bed were examined by G. H. Ashley for the purpose of collecting material to be subjected to distillation experiments.

The Pleistocene formations and physiography of the Baldwin, Chester, Renault, Kimmswick, and Crystal City quadrangles were further studied by E. W. Shaw with a view to their description in cooperative folios.

Folios for the Carlyle, Centralia, New Athens, and Okawville quadrangles were nearly completed by Mr. Shaw, the greater part of whose time was devoted to studies of Pleistocene deposits and sedimentation in the Gulf region of the Coastal Plain.

INDIANA.

A report on "The Pleistocene of Indiana and Michigan and the history of the Great Lakes," by Frank Leverett and F. B. Taylor, was published as Monograph 53.

In connection with the discussion and correlation of the formations in the vicinity of Cincinnati, Ohio, the Paleozoic formations and faunas in southeastern Indiana were studied by E. O. Ulrich.

Field examinations of the Devonian black shales in the New Albany region and of the dark shales and bony layers associated with some of the coal beds of the State were made by G. H. Ashley, who collected samples for laboratory distillation in order to determine their value as sources of petroleum distillates and their by-products.

IOWA.

A review of the evidence of an Iowan stage of glaciation and of its relations to the deposits of other Pleistocene stages in eastern Iowa and adjoining States occupied W. C. Alden during the greater part of the field season of 1914. This work was done in cooperation with the Iowa State Geological Survey, which furnished an assistant, Morris M. Leighton, for the season. The studies were resumed in June, 1915.

A short field conference on the mapping of the Quaternary deposits of northwestern Iowa was held between E. S. Carman, of the State Geological Survey, and Frank Leverett.

A short report containing a summary description of the coal fields and coals of Iowa was prepared by Henry Hinds for incorporation in the general report by M. R. Campbell on the coal fields of the United States.

The stratigraphy of the Mississippian formations in southeastern Iowa was examined and collections of fossils were made by F. M. Van Tuyl, of the State Geological Survey, the paleontologic supervision of the investigation being, through informal cooperation, in charge of Stuart Weller, who has conducted similar investigations for the Federal Survey in Missouri, Illinois, and western Kentucky.

KANSAS.

The description of the ore deposits of the Joplin district, Missouri, and of the Miami district, Oklahoma, with field studies extending into southeastern Kansas, was continued by C. E. Siebenthal, whose report on the origin of the zinc and lead deposits of the Joplin region (Bulletin 606) is now in press.

The Leavenworth-Smithville folio, by Henry Hinds and F. C. Greene, has been revised by Mr. Hinds.

KENTUCKY.

A detailed survey of the areal geology and mineral resources of Jefferson County, Ky., was completed by Charles Butts, assisted by T. C. Brown and J. J. Galloway. This survey was made in cooperation with the Kentucky Geological Survey, to which the report, now nearing completion, will be submitted for publication. Several quadrangles, including the Louisville and Kosmosdale, lie wholly or in part within Jefferson County, and it is planned that folios shall be prepared after certain problems have received further field consideration and after small areas lying outside of the county have been mapped.

Field studies in the stratigraphy and paleontology of the early Paleozoic formations of central Kentucky and in the Louisville quadrangle were made by E. O. Ulrich.

Several Carboniferous sections in southeastern Kentucky were examined for purposes of correlation by G. H. Girty.

The phosphate deposits in Woodford and adjoining counties have been examined partly in reconnaissance and partly in detail by W. C. Phalen, who explored portions of this relatively little known phosphate field by means of shallow drilling. A large number of samples were collected for chemical analysis. The results of these investigations are designed to be incorporated in a report on the phosphate deposits of the southern Appalachian region.

A study of the physiography and the Quaternary geology of the western part of the State, by E. W. Shaw, is in progress as a part of an investigation covering the late Pleistocene geologic history of the Mississippi embayment.

Professional Paper 91, "The lower Eocene floras of southeastern North America," by E. W. Berry, including areas in Kentucky, is in press.

LOUISIANA.

With the object of guiding exploration in the discovery and the development of oil pools in Louisiana, preliminary reconnaissance examinations of the geologic structure with special reference to the presence of oil and gas were made by G. C. Matson, assisted by O. B. Hopkins and E. H. Finch, in a number of districts, most attention, however, being given to Bossier, De Soto, Caddo, and Red River parishes. Reports covering this work are now in preparation. At the request of the General Land Office an examination of the islands in Sabine River near Orange, Tex., was made by Mr. Hopkins for the purpose of land classification.

A report on the iron-bearing deposits in Bossier, Caddo, and Webster parishes, by E. F. Burchard, the field work for which was done in the fall of 1914, is ready for publication as Bulletin 620–G.

The upper Tertiary formations in southwestern Louisiana were examined by G. C. Matson and Alexander Deussen, and fossil plants and invertebrates from several localities and formations have been studied by E. W. Berry and C. Wythe Cooke. Reports now in preparation include a study of the floras of the Claiborne and Jackson groups by Mr. Berry and a general report on the physiography and surficial geology of the Gulf embayment by E. W. Shaw. A manuscript by Mr. Matson on the Pliocene of the eastern and central Gulf Coastal Plain and two manuscripts on the Catahoula formation, the stratigraphy being described by Mr. Matson and the fossil plants by Mr. Berry, were transmitted for publication.

Supplementary investigations of the stratigraphy, paleontology, and ground waters of the Cretaceous deposits of northeastern Louisiana were made by L. W. Stephenson.

Professional Paper 91, "The lower Eocene floras of southeastern North America," by E. W. Berry, is in press, and Bulletin 619, "The Caddo oil and gas field, Louisiana," by G. C. Matson, is in the hands of the editor.

MAINE.

Additional field examinations were made by Frank J. Katz in the Portland and Casco Bay quadrangles for the solution of problems which arose during the office preparation of a folio for these quadrangles. This review, during which Mr. Katz was joined by Arthur Keith for field conference and inspection, was not made in cooperation with the State, though the greater part of the previous work on these quadrangles was done in cooperation. The text and maps for this folio are nearing completion.

The areal survey of the Dover and York quadrangles was commenced by Mr. Katz, who has covered about 50 square miles, and progress was made on the maps and collections in the office.

In the Boothbay quadrangle a brief reconnaissance covering about 20 square miles was made by Mr. Keith.

Professional Paper 89, "The fauna of the Chapman sandstone," by H. S. Williams, has been revised by the author and a chapter on the Ostracoda of the formation has been added by E. O. Ulrich. This paper is now in press.

MARYLAND.

The mapping of the Williamsport quadrangle, which includes portions of West Virginia and Pennsylvania, was completed by George W. Stose, who covered about 100 square miles in detail. The descriptions and maps for this quadrangle, which with the Hagerstown quadrangle will be covered by a single folio, are well advanced toward completion. This folio was provided for under cooperation with the Maryland Geological Survey. Conferences for deciding certain questions of stratigraphy and correlation were held by Mr. Stose, E. O. Ulrich, and R. S. Bassler in the Hagerstown and Frederick quadrangles.

The folio for the Elkton and Wilmington quadrangles, including parts of Pennsylvania and Delaware, was transmitted for publication. This folio was prepared by Miss Florence Bascom and B. L. Miller, in cooperation with the Geological Survey of Maryland.

The Tolchester folio, by B. L. Miller, E. B. Mathews, Arthur B. Bibbins, and Homer P. Little, also cooperative, was completed and transmitted for publication.

At the request of the Committee on Public Buildings of the House of Representatives a marble quarry near Union Bridge, Carroll County, was examined by T. N. Dale, in association with Oliver Bowles, quarry technologist of the Bureau of Mines. A short report on the rocks examined was transmitted to the committee.

In order to ascertain whether the small emissions of gas proceeding from a number of shallow wells driven for water in the region of Salisbury, Md., were of deep-seated (rock) origin, and if so whether they might be regarded as indications of possible gas or oil pools in the region, an examination was made by G. C. Matson. The results of this investigation were not sufficiently encouraging to merit formal publication.

For the more accurate differentiation and discrimination of the Pleistocene formations of the Maryland portion of the Coastal Plain an inspection of the terraces of peninsular Maryland was made by T. Wayland Vaughan, E. W. Berry, and P. S. Smith, in conference with W. B. Clark, director of the State Geological Survey.

MASSACHUSETTS.

Reviews necessary to the completion of the descriptions of the Boston and Boston Bay quadrangles were made by Laurence La Forge. The preparation of the Boston folio, which is to cover these quadrangles, is now well advanced. Reconnaissance examinations were made by Mr. La Forge in the Haverhill, Lowell, Lawrence, Newburyport, and Salem quadrangles. A field conference was held in the Framingham quadrangle by Mr. La Forge and Arthur Keith, who inspected the geologic mapping.

The areal and economic survey of the Greylock quadrangle was continued by L. M. Prindle, who conferred with Mr. Keith in the field.

The Sheffield-Sandisfield folio was the subject of an office conference between Arthur Keith, Joseph Barrell, and B. K. Emerson. Mr. Keith also conferred with Mr. Emerson regarding the Pittsfield and Becket geologic work and certain features of Mr. Emerson's report on the geology of Massachusetts (Bulletin 597).

Manuscript maps and geologic descriptions for the Worcester-Marlboro, Palmer-Brookfield, Webster-Blackstone, and Belchertown-Barre folios have been submitted by Mr. Emerson, and his office work on the Warwick-Winchendon folio has been continued to an advanced stage.

Field studies of the geology of Cape Cod, Nantucket, Marthas Vineyard, and the Elizabeth Islands were begun in June by J. B. Woodworth, with the object of mapping and preparing a report on the geology of this portion of the Atlantic Coastal Plain.

The field examination of the Quaternary geology of the Berlin and Greylock quadrangles, in New York and Massachusetts, was completed by F. B. Taylor, who has prepared a manuscript describing the surficial deposits for folio publication.

Deposits containing tourmaline, beryl, and lithia minerals in the vicinity of West Chesterfield and Goshen, Hampshire County, were examined by D. B. Sterrett.

MICHIGAN.

The report on "The Pleistocene of Indiana and Michigan and the history of the Great Lakes," by Frank Leverett and F. B. Taylor, has been published as Monograph 53, and a special report on the extent and relations of the Superior ice lobe in Michigan, Wisconsin, and Minnesota is in preparation by Mr. Leverett.

In accordance with an informal arrangement for cooperation with the Michigan Geological Survey in paleontologic investigations, the Marshall fauna of the State has been studied by G. H. Girty.

MINNESOTA.

The work of mapping the glacial deposits of Minnesota, with special reference to the origin of the soils, was continued by Frank Leverett, assisted by F. W. Sardeson, of the State Geological Survey. A report entitled "Surface formations and agricultural conditions of northwestern Minnesota," by Frank Leverett, with a chapter on the climatic conditions of Minnesota, by U. G. Pursell, was transmitted to the State and published as Bulletin 12 of the Minnesota Geological Survey. This is the first of a series of papers to be based on this work. Manuscript for a report on the soils and surface deposits of northeastern Minnesota has been prepared by Mr. Leverett for publication by the State, and he has done considerable work, with the assistance of Mr. Sardeson, on a general report on the Quaternary deposits and history of Minnesota, to be published by the Federal Survey.

A brief reconnaissance study of the pre-Wisconsin Quaternary deposits in some of the southeastern counties of the State was made by W. C. Alden, for comparison with similar deposits in Iowa. Field conferences regarding the mapping and classification of these deposits were held between Messrs. Leverett, Sardeson, and Alden and between T. C. Chamberlin and Mr. Leverett.

Cooperative studies preliminary to a general report on the stratigraphy and economic geology of the Cuyuna iron range were made by E. C. Harder, of this Survey, and A. W. Johnstown, of the State Survey. A preliminary paper on the bacterial deposition of iron ores has been prepared by Mr. Harder for publication in "Shorter contributions to general geology." Under cooperative agreement also studies of the magnetite ores of the State were begun by F. F. Grout, of the Minnesota Survey, and H. H. Brodt.

As products of previous cooperative work conducted with the State Geological Survey a report on the clays and shales of Minnesota, by F. F. Grout, and a similar report on the building stones of the State, by Oliver C. Bowles, were completed and submitted for publication in bulletin form.

MISSISSIPPI.

Structural studies for the purpose of finding geologic conditions favorable to the occurrence of oil or gas in the Vicksburg quadrangle, Miss., were carried on by G. C. Matson, O. B. Hopkins, and E. H. Finch. A report containing the results of this investigation is now in preparation. Brief examinations were also made by Mr. Matson at Hattiesburg, Natchez, and Seminary.

Reports on the geology of the Coastal Plain of Mississippi and on the ground waters of the State are in preparation. The investigations have been carried on in cooperation with the State Geological Survey of Mississippi, field work being done by five geologists of the Federal Survey and E. N. Lowe, State geologist.

The examinations of the upper Eocene and Oligocene formations in the State were continued by C. Wythe Cooke, who has transmitted a paper entitled "The age of the Ocala limestone" (Professional Paper 95–I). This report will be of special value for correlation.

A report on the physiography, surficial deposits, and Pleistocene geologic history of the Gulf embayment, which is in preparation by Mr. Shaw, will embrace the State of Mississippi. In connection with this investigation Mr. Shaw is making a special study of the silts of the Mississippi Valley.

Additional field studies of the post-Eocene geologic formations were made by G. C. Matson, who cooperated with Mr. Shaw in a part of the investigations of the latest Tertiary and Pleistocene formations.

A report on the fossil flora of the Claiborne group, which is exposed in Mississippi, is in preparation by E. W. Berry. Reports covering the results of earlier field and office investigations submitted during the year include a manuscript on the Pliocene of the eastern and central Gulf Coastal Plain by G. C. Matson; two manuscripts on the Catahoula formation, one on the stratigraphy by Mr. Matson and one on the fossil plants by Mr. Berry; and a manuscript entitled "Erosion intervals in the Eocene of the Mississippi embayment," by Mr. Berry (Professional Paper 95–F).

Professional Paper 91, "The lower Eocene floras of southeastern North America," by E. W. Berry, is now in press.

MISSOURI.

A report by C. E. Siebenthal on the origin of the Joplin lead and zinc ores, now in press as Bulletin 606, contains conclusions based on a long and thorough investigation of the geology and ore deposits of the Joplin region.

In response to a request of the State geologist the earlier Paleozoic formations of eastern and central Missouri were briefly studied for purposes of classification and correlation by E. O. Ulrich. On the part of the State additional investigations, both paleontologic and stratigraphic, of the Mississippian formations, mainly in Ste. Genevieve County, were made by Stuart Weller.

Further field examinations of the Pleistocene deposits in the Crystal City and Renault quadrangles, for which geologic folios are in preparation in cooperation with the Missouri Bureau of Geology and Mines, were made by E. W. Shaw.

The Green City-Queen City folio text, by F. C. Greene, was critically revised by Henry Hinds, under whose supervision the field and office work relating to these quadrangles was done. Some revisory work was also done by Mr. Hinds on the Leavenworth-Smithville folio, the geologic maps for which are now engraved.

A chapter describing in summary form the coal fields of Missouri was prepared by Mr. Hinds for inclusion in the work by M. R. Campbell on the coal fields of the United States.

MONTANA.

A portion of the Judith River coal field in northeastern Chouteau and Fergus counties, Mont., embracing about 600 square miles, was geologically surveyed in a detailed reconnaissance examination by E. R. Lloyd, assisted by W. T. Thom, jr., and W. B. Wilson. The lands of this area have been classified and an economic report has been prepared, but the publication of this report will be delayed to incorporate the results of additional field work. A paleontologic study of the Cretaceous and Eocene formations of this region was made by T. W. Stanton for purposes of correlation.

A report on the subbituminous coal and lignite regions of eastern Montana is in preparation by E. R. Lloyd for publication in the forthcoming paper on the coal fields of the United States. The completion of Mr. Lloyd's manuscript is somewhat retarded on account of his recent transfer from the geologic branch to the land-classification board, where he was made secretary of the coal board.

The geology and coal resources of northern Teton County will be described by Eugene Stebinger in Bulletin 621–K.

An area of about 1,300 square miles in the Porcupine dome, north of Forsyth, was examined in a reconnaissance way, for the purpose of land classification, by C. F. Bowen, assisted by C. A. Bonine. The possibilities of oil in the Porcupine dome have been described by Mr. Bowen in Bulletin 621–F. Mr. Bowen also submitted a report on the stratigraphy of the Montana group, with special reference to the stratigraphic position and age of the Judith River formation, which has been published as Professional Paper 90–I.

A description, with maps, of the Tullock Creek coal field, which was examined in 1912–13, was completed and submitted for publication by G. S. Rogers, and a report on the Bull Mountain coal field, by R. W. Richards and C. T. Lupton, has been submitted.

A small area of lignite land near Glendive was examined for the purpose of classification by C. E. Lesher.

The areal mapping of the coal fields of southeastern Montana, which was begun in 1913, was continued by C. M. Bauer, with the assistance of E. M. Parks and R. W. Brown. This work was done primarily for purposes of land classification, but the areal geology was also studied and mapped. Mr. Bauer examined about 800 square miles in more or less detail, and 1,500 square miles, mainly outside of the coal field, in a rapid reconnaissance. An economic report on the Ekalaka and Long Pine Hills coal field of southeastern Montana, studied in 1913–14, is now in preparation by Mr. Bauer.

An examination of the northeast corner of this State, north of the Fort Peck Indian Reservation, was begun by A. J. Collier, assisted by W. T. Thom, jr., for the purpose of classifying the land. An investigation of the Milk River valley was undertaken by Eugene Stebinger, assisted by W. P. Woodring and J. D. Sears.

The paleontology and stratigraphy of the formations on the north side of Yellowstone River, west and north of Forsyth, were studied by T. W. Stanton, who, in cooperation with C. W. Gilmore and the field party in charge of E. R. Lloyd, also made a careful review of the type area of the Judith River formation on the Missouri near the mouth of the Judith.

The placer deposits at Ruby and Virginia City were visited by J. M. Hill in connection with his general investigation, cooperative with the Bureau of Mines, of the placer deposits of the United States.

In the Browning and Chief Mountain quadrangles, in the Glacier National Park, areal geologic mapping was continued by Eugene Stebinger, with the assistance of C. S. Corbett and H. R. Bennett, about 725 square miles being mapped in detail on the 1:125,000 scale. Progress in the preparation of a report for the area has been made by Mr. Stebinger, who also prepared text, maps, and illustrations for the Blackfoot-Cutbank folio, the areal mapping of which was completed during the previous field season.

Final revision of the text of the Philipsburg folio was completed by F. C. Calkins.

NEVADA.

In the search for potash, under the supervision of H. S. Gale, boring was continued to a depth of 1,500 feet in the Black Rock Desert, Nev., when the coming of winter terminated the work. The drill crew was superintended by D. H. Walker, to whose skill and efficiency are due the economy and speed of the work and the completeness of the data gathered. Samples of the drillings were collected by M. I. Goldman and A. T. Crandall, and these are now undergoing analytical study by Mr. Goldman. Through the courtesy of the Department of Agriculture the diatoms have been examined by Dr. Albert Mann, specialist in the Diatomaceæ. A number of reported discoveries of potash salts or nitrates within the State were investigated by Mr. Gale, and analyses of submitted samples of salts were made in the chemical laboratory. No bed of potash salts was discovered in the deep well. The reported deposits proved on examination to be either too low in potash or nitrates or too small to be of commercial importance.

In the spring of 1915 a new drilling equipment designed especially for the work and region was purchased, and surveys were made in the Smoke Creek Desert by Mr. Gale to determine localities that would appear relatively favorable for testing. Preparations were completed by Mr. Walker to resume drilling in that desert with the new rig early in July.

Nitrate-bearing beds north and northwest of the Black Rock Desert were examined by M. I. Goldman.

The Yerington district was studied in detail by Adolph Knopf and E. L. Jones, jr., who mapped 58 square miles on the scale of 1: 24,000. The results of this survey are now being prepared for publication. The cinnabar deposits east of Beatty and Mina were examined by Mr. Knopf, the results of whose investigations have been submitted for publication under the title, "Some cinnabar deposits in western Nevada" (Bulletin 620–D). The platinum deposits in the Yellow Pine district, Clark County, were investigated by Mr. Knopf, whose report, "A gold-platinum-palladium lode in southern Nevada," has appeared as Bulletin 620–A. A paper entitled, "Plumbojarosite and other basic lead-ferric sulphates from the Yellow Pine district, Nevada," was prepared by Mr. Knopf for unofficial publication.

The Rochester mining district is described by F. C. Schrader in Bulletin 580–M, issued during the year, and a report on "Some mining districts in northeastern California and northwestern Nevada" (Bulletin 594), by J. M. Hill, was also published.

A reconnaissance report on some mining districts in eastern Nevada, mostly in Elko, White Pine, Lincoln, and Clark counties, and on the Ravenswood district, in Lander County, has been submitted for publication by Mr. Hill.

The economic geology of the National district is described by Waldemar Lindgren in Bulletin 601, recently issued; and a detailed report on the geology and ore deposits of the Ely district, by A. C. Spencer, is in the editor's hands. In the preparation of the Ely report Sidney Paige collaborated in the office with Mr. Spencer.

The oxidized zinc ores near Eureka were investigated by G. F. Loughlin, the mining districts of the Carson Sink quadrangle are being described by F. C. Schrader, and an examination of the geology and ore deposits of the Manhattan district was begun by H. G. Ferguson.

A short paper on the occurrence of wurtzite at Goldfield was unofficially published by F. L. Ransome.

The silver ores of the Tonopah district are under investigation by metallographic methods, with reference to their association and origin, by E. S. Bastin, in collaboration with F. B. Laney.

NEW HAMPSHIRE.

Mica deposits, locally with gem beryl as an associated mineral, were examined in eleven townships in Grafton, Cheshire, and Stratford counties, N. H., by D. B. Sterrett, who nearly completed the field investigation of the principal deposits, preliminary to a description of the occurrence of mica in New Hampshire. The gem deposits will be described in a report on the occurrence of precious stones in the United States now in preparation.

The areal survey of the Dover and York quadrangles, including portions of Maine, was begun by F. J. Katz, who has also begun the office compilation of the field data.

The examination of the Peterboro quadrangle was continued during a portion of the field season by B. K. Emerson, who for a time was joined in a field reconnaissance by Arthur Keith. A brief reconnaissance was made in the Keene quadrangle by Mr. Keith. Portions of the Lowell, Lawrence, and Newburyport quadrangles, lying partly in Massachusetts, were examined by Laurence La Forge.

NEW JERSEY.

The areal survey of the Easton quadrangle, in New Jersey and Pennsylvania, was completed by H. B. Kümmel, the work being carried on in cooperation with the New Jersey Geological Survey. The manuscript and maps for this quadrangle will form part of the Allentown-Easton folio and are well advanced toward completion.

In accordance with the plan of the Survey to print on the backs of topographic maps that cover large centers of population or points of unusual scenic interest popular and instructive descriptions of the geography and of the origin of the physical features, a description of this sort was prepared by G. W. Stose for the Delaware Water Gap sheet. This description is based on field work done in the quadrangle, which lies largely in Pennsylvania, by W. S. Bayley and H. B. Kümmel, and on Mr. Stose's personal knowledge of the region. The general geologic data now available as to the quadrangle will probably be amplified when the study of the adjoining Wind Gap quadrangle has been made in order that both quadrangles may be covered in a single folio.

NEW MEXICO.

In connection with the general search for deposits of potash and nitrate salts, the investigation of the depositional basins in the "Red Beds" region of New Mexico was continued by N. H. Darton, whose principal object was to discover the centers of greatest evaporation of saline waters in the past.

The chief study of metalliferous areas undertaken in New Mexico during the year was that of the copper deposits at Santa Rita (Chino district), to which A. C. Spencer was assigned. With Mr. Spencer were associated Sidney Paige, who studied the structure and superposed the geology on the Santa Rita special map; D. F. MacDonald, who examined the mining methods, especially the open-pit mining; and J. F. Hunter, jr., who assisted in the areal geologic mapping. Toward the close of the field season the district was visited by F. L. Ransome for the discussion of problems with Mr. Spencer.

The studies of mining methods by Mr. MacDonald were carried on in connection with the general investigation of the application of geologic features to the problems of mining and engineering construction, prosecuted in cooperation with the Bureau of Mines.

A study of the zinc ores of the Magdalena district was begun by G. F. Loughlin.

The geology and water resources of Luna County are described by N. H. Darton in Water-Supply Paper 345–C, recently issued.

A study of the geology and coal resources of the Raton and Brilliant quadrangles, in the Raton coal field, Colfax County, was completed by W. T. Lee, and an economic report covering the area has been submitted for publication. A folio by Mr. Lee describing in detail the geology of the quadrangles is in preparation.

The Datil Mountain region was revisited by D. E. Winchester for the purpose of collecting additional information regarding the stratigraphy and correlation of certain coal beds. Field work is now completed in the Datil Mountain region and in the Zuni Indian Reservation, and an economic report on these areas is in preparation by Mr. Winchester.

At the request of the Office of Indian Affairs, lands coming under the Hogback canal in the Navajo Indian Reservation were examined in 1913 by M. A. Pishel. A report on the area was submitted by Mr. Pishel prior to his resignation from the Survey to accept a more remunerative position in one of the large oil companies operating in the Southwest.

A detailed examination, for the General Land Office, of lands near Gallup, McKinley County, was made by C. T. Lupton, who is now preparing a geologic report on the area.

An extended and elaborate study of the San Juan coal basin, in the northwest corner of the State, was begun by C. M. Bauer, assisted by J. B. Reeside, jr., the purpose being to obtain data for classifying the lands in the interior of this great basin and for determining the age and the correlation of the formations. The results of this investigation will be available for use in preparing the Red Mesa and Soda Canyon folios.

NEW YORK.

The mapping of the Quaternary deposits of the Berlin (N. Y.–Mass.) and Hoosick (N. Y.–Vt.) quadrangles was completed in July, and descriptions for folio publication have been nearly completed by

F. B. Taylor. The areal and economic survey of the Paleozoic formations in the Berlin quadrangle, which includes a small portion of Massachusetts, was continued by L. M. Prindle, about 125 miles having been mapped in detail.

The examination and mapping of the Paleozoic formations in the Hoosick quadrangle was completed by Mr. Prindle, who will describe this quadrangle in a folio covering also the Bennington quadrangle.

The study of the Quaternary deposits of the Cambridge and Fort Ann quadrangles was begun by Mr. Taylor.

NORTH CAROLINA.

Manuscripts and maps for a folio describing the Kings Mountain and Gaffney quadrangles, the larger part of which lie in South Carolina, has been nearly completed by D. B. Sterrett.

The Lincolnton quadrangle has been mapped by Mr. Sterrett, who has prepared descriptions for inclusion in a folio to cover also the Gastonia quadrangle, in which field work will be begun this summer.

Some mica deposits in Avery, Mitchell, and Macon counties and the results of the latest prospect work done in 1914 at the Ruby mine, in Cowee Valley, were examined by Mr. Sterrett, who visited several mica manufacturing plants to study the conditions of the industry.

In connection with a report on the marbles of the southeastern United States, which is being prepared in cooperation with the Bureau of Mines, the Bureau of Standards, and the Office of Public Roads, T. Nelson Dale devoted a short time to field investigations in this State.

The preparation of a cooperative monograph on the worms and mollusks of the Upper Cretaceous deposits of the Carolinas, by L. W. Stephenson, to be published by the North Carolina Geological and Economic Survey, has been nearly completed and the report will soon be transmitted. The Cretaceous Crustacea from the State have been described by Miss Mary T. Rathbun, of the United States National Museum, in a report to accompany Mr. Stephenson's paper, and the fossil plants have been described for the same purpose by E. W. Berry.

A monograph describing the Tertiary Mollusca of Virginia and North Carolina, for which Dr. Paul Bartsch, of the National Museum, described several families of the smaller Mollusca, has been completed by Miss Julia Gardner. The services of all those who are engaged on this work, except Mr. Stephenson, were contributed in scientific cooperation, without expense to the Survey.

A monograph on the Pliocene and Pleistocene Foraminifera of the Atlantic and Gulf Coastal Plain, in which the Foraminifera from North Carolina are included, has been transmitted for publication by J. A. Cushman.

NORTH DAKOTA.

A detailed reconnaissance survey, covering about 590 square miles in the Oliver County lignite field, North Dakota, was made by E. T. Hancock, with the assistance of R. C. Moore. The results of this examination, which was made primarily for land classification and to solve certain problems relating to the stratigraphy of the region, have been embodied in a geologic report by Mr. Hancock, now nearly completed. In connection with the field investigations, studies relating to the stratigraphy of the Cannonball marine member of the Lance formation and to the stratigraphy and faunas of the Cretaceous and Eocene formations in surrounding regions were made by T. W. Stanton, who examined exposures north and south of Steel, near Jamestown, between Linton and Missouri River, and along Cannonball and Wisconsin rivers from Solen to Washburn.

The Fort Berthold lignite field is described and mapped in a final report submitted by C. M. Bauer, who has also prepared a short summary report on the lignite resources of North Dakota for inclusion in the general report on the coal fields of the United States.

The geology of the Edgeley and Lamoure quadrangles has been examined for folio publication by H. A. Hard under a cooperative agreement with the State Geological Survey of North Dakota.

OHIO.

A folio for the Hamilton and Mason quadrangles, which were mapped in detail by R. S. Bassler and N. M. Fenneman, as previously reported, is nearly finished, its completion awaiting only the results of additional investigations, largely paleontologic, to be made by E. O. Ulrich in the Cincinnati quadrangle. Some general review work was done by Mr. Ulrich in the quadrangle.

The areal and economic geology of the Woodsfield and Summerfield quadrangles was examined in detail by D. Dale Condit, assisted by R. V. A. Mills and for a short time by C. A. Bonine. Careful attention was given to the structure of the oil sands and the relations of the oil pools to the geologic structure and to the character of the sands themselves. Two economic reports on the structure and oil resources of these quadrangles are now nearly completed and a folio is in preparation.

Some progress has been made in the preparation of a folio text covering the Steubenville and Cadiz quadrangles, on which Mr. Condit had been previously engaged; but this work was interrupted by his detail to examine and classify supposed phosphate-bearing lands in western Wyoming.

A preliminary examination of the Wooster oil and gas field was made by C. A. Bonine, and a report on the geologic structure, the mode of occurrence of oil and gas, and the prospects of the field has been submitted by Mr. Bonine for publication (Bulletin 621–H).

The field investigation and mapping of the Wellsville quadrangle were carried on by J. H. Hance, special attention being given to the clay deposits and the clay-bearing formations.

The richly carbonaceous Devonian shales were examined and sampled at a number of points by G. H. Ashley, with a view to determining their value for distillation.

OKLAHOMA.

In order to procure further data as to the structure of the oil sands in the Hominy quadrangle, Oklahoma, some additional reconnaissance work was done by Robert H. Wood, whose oil report for the quadrangle is nearing completion and whose folio is well advanced. Considerable progress was made by Mr. Wood on the economic report covering the Cleveland pool.

The Pawhuska quadrangle was revisited by C. D. Smith for the purpose of verifying certain conclusions he reached during the office study of his notes, and considerable progress has been made on the folio covering the quadrangle. The folio for the Claremore quadrangle, which also was visited for slight revision, was nearly completed when, at the end of January, Mr. Smith resigned from the Survey in order to make a more lucrative use, as consulting oil geologist, of his practical knowledge and experience in oil-field geology. However, Mr. Smith has agreed to complete the folio.

Considerable progress has been made by Mr. Smith in the preparation of a folio covering the Sallisaw and Sanbois quadrangles, the geologic mapping of which was begun some years ago by J. A. Taff, a former member of the Survey now in the employ of the Southern Pacific Co. The completion of this folio, which had been delayed pending the receipt of additional data from Mr. Taff, is now subject to further postponement on account of Mr. Smith's resignation.

The areal and economic survey of the McAlester quadrangle was completed a number of years ago by Mr. Taff, who is under agreement to complete a folio for this area.

The Paleozoic geology and the Quaternary deposits in the northern half of the Windingstair quadrangle and the eastern part of the Tuskahoma quadrangle was briefly reviewed by H. D. Miser. The areal work in these quadrangles was begun a number of years ago by Mr. Taff.

The Loco, Duncan, and Lawton districts were examined by C. H. Wegemann, assisted by R. W. Howell and K. C. Heald, with the object of discovering the relation of the oil pools to the geologic structure and of obtaining information for guidance in the extension of known pools and the possible discovery of new ones. Preliminary accounts, with sketch maps covering the areas, were transmitted to the Oklahoma Geological Survey, by which they have since been published.

Work on the Healdton pool, which was begun last year, was continued by Mr. Wegemann, assisted by Mr. Heald, and a report thereon is in press as Bulletin 621–B. Reports on the Loco and Duncan (Hope) gas fields and on the Lawton gas and oil pool, by Mr. Wegemann and R. W. Howell, are in press as Bulletins 621–C, 621–D, and 621–G, respectively.

Structural examinations, with reference to the possible occurrence of oil and gas, were made in portions of Okmulgee and Okfuskee counties by A. E. Fath, assisted during part of the field season by W. B. Emery and K. C. Heald. A report on "Faulted structure in the vicinity of the recent oil and gas development near Paden, Okfuskee County, Okla.," has been submitted by Mr. Fath. He also prepared a paper for unofficial publication on the segregation of copper ores in the "Red Beds."

The economic and areal survey of the geology of the Foraker quadrangle was begun by Mr. Heald and a similar investigation of the Bristow quadrangle by Mr. Fath.

Additional examinations of the lead and zinc deposits of the Miami district were made near the close of the year by C. E. Siebenthal. The data will be used in a report on these deposits which is now in preparation by him.

"The fauna of the Wewoka formation of Oklahoma," by G. H. Girty, was published as Bulletin 544.

OREGON.

In the Sumpter quadrangle, Oregon, about half of which had previously been examined, the remaining part was geologically surveyed in detail on the scale of 1 : 125,000, for folio publication, by J. T. Pardee and D. F. Hewett under a cooperative agreement with the Oregon Bureau of Mines and Geology, to which a preliminary report on the mineral resources of the quadrangle was submitted for publication. In June Mr. Hewett made some reconnaissance examinations in the region immediately west of the quadrangle. A geologic folio for Sumpter quadrangle is now in preparation for publication by the Federal Survey.

A reconnaissance examination of the Howard mining district was made in August by G. F. Loughlin.

Nitrate prospects in Malheur County, not far from Homedale, Idaho, were visited by G. R. Mansfield, whose report was submitted for publication (Bulletin 620–B).

The investigation of the Eden Ridge coal field was completed by C. E. Lesher, who examined in detail 36 square miles and in reconnaissance 200 square miles, covering parts of Eden Ridge and Camas Valley. The stratigraphic position of the scattered coal outcrops was determined by Mr. Lesher, thus defining the productive formation. A portable outfit devised for the field determination of the amount of ash in coals is described by Mr. Lesher in Bulletin 621-A.

PENNSYLVANIA.

The region between the Bellefonte and Huntingdon quadrangles, Pennsylvania, which have already been under examination, was reviewed in reconnaissance by Charles Butts, for the purpose of tracing certain formations between the two quadrangles and determining their stratigraphic relations. The folio for the Huntingdon and Hollidaysburg quadrangles is near completion, lacking only a review of certain details. A conference will be held by Mr. Butts and E. S. Moore, geologist engaged in the study of the Bellefonte quadrangle, before the folio for that quadrangle can be completed for publication. In connection with the description by C. D. Walcott, secretary of the Smithsonian Institution, of the Cambrian paleontology and stratigraphy of the United States, Mr. Butts spent some time in working out the Cambrian-Ordovician relations in the Hollidaysburg quadrangle.

A description of the physical features in the Delaware Water Gap quadrangle and the geography of the region was prepared by G. W. Stose. (See New Jersey, p. 75.)

Field work on the Fairfield and Gettysburg quadrangles having been completed, the manuscript and maps for a folio are in preparation by Miss Florence Bascom and G. W. Stose. A petrographic report on the Triassic lavas, for incorporation in this folio, was prepared by J. Volney Lewis.

The folio covering the Elkton and Wilmington quadrangles, by Miss Bascom and B. L. Miller, has been transmitted for publication. (See Maryland, p. 68.)

The geology of the Allentown quadrangle has been the subject of a field conference between Arthur Keith, in charge of the work, and B. L. Miller and H. B. Kümmel, geologists responsible for the mapping of the Allentown and Easton quadrangles, respectively. Mr. Miller has completed the maps and text for the Allentown quadrangle, and Mr. Kümmel is preparing similar material for the Easton quadrangle, the greater portion of which lies in New Jersey. The two quadrangles will be covered by a single folio. A report on the geology and economic resources of the Allentown quadrangle has been submitted by B. L. Miller.

Additional field work, mainly in adjustment of geologic boundaries to a new topographic base for the Reading quadrangle, has been completed in the Reading and Boyertown quadrangles by Miss Bascom and Edgar T. Wherry, assistant. Mr. Wherry also examined recently operated quarries and mines in both quadrangles in order to complete his description of the economic geology and developments in the area. The pre-Cambrian rocks in the Reading quadrangle were mapped by Miss E. F. Bliss. Miss Bascom's work of preparing the folio is now well advanced.

The survey of the areal geology of the McCalls Ferry and Quarryville quadrangles, begun by E. B. Mathews, was continued by Miss Bliss. The results are to be published in folio form.

Field investigations were carried on by Mr. Wherry and Miss Bliss in the Quakertown and Doylestown quadrangles, the Paleozoic rocks being partly mapped by Miss Bliss and the Triassic rocks by Mr. Wherry. A portion of the folio for these two quadrangles is to be prepared by Miss Bascom and is well advanced toward completion.

Considerable progress has been made by Miss Bascom on the manuscript and maps for the Coatesville and West Chester quadrangles, which will be covered by a single folio, and on the Honeybrook-Phoenixville folio, which she expects to complete during the coming year.

Several local investigations regarding artesian-water conditions in eastern Pennsylvania have been made by Miss Bascom.

Satisfactory progress has been made in the investigation and mapping of the geology of the Frostburg and Flintstone quadrangles, which are to be covered by a single folio. The field and office work by Mr. Stose for his part of the folio has been finished for some time, and the completion of the folio manuscript awaits the descriptions to be furnished by C. K. Swartz for the Devonian and Carboniferous formations. The work is being done in cooperation with the Maryland Geological Survey.

The preparation of maps and descriptions of the geology and mineral resources of the Punxsutawney, Curwensville, and Houtzdale quadrangles has been continued by G. H. Ashley whenever his other duties gave opportunity.

The deposits of cannel coal and the richly carbonaceous shale mined or exposed at several points in western Pennsylvania were examined by Mr. Ashley, who collected a number of samples for tests in order to determine their ultimate value as possible sources of gas or petroleum distillates and distillation by-products.

Some progress has been made in the preparation of the Newcastle folio, although the demands made upon F. W. De Wolf, the author, by his duties as State geologist of Illinois are so overwhelming that little time is available for the Pennsylvania work.

The geology of the Windber quadrangle has been investigated in detail by George B. Richardson, who has submitted a folio to cover the Windber and Somerset quadrangles, the latter having been examined during the preceding season. An economic report entitled "Geologic structure and coal resources of the Windber and Somerset quadrangles, Pennsylvania," has been nearly completed by Mr. Richardson.

RHODE ISLAND.

In connection with the investigations of the stratigraphy, paleontology, underground water resources, and physiography of the Atlantic Coastal Plain, the examination of Cape Cod and the islands off the south coast of Massachusetts and Rhode Island, including Block Island, was undertaken by J. B. Woodworth.

A report, briefly describing the Rhode Island coal field and discussing in particular the composition and adaptations of the coals of the State, by G. H. Ashley, is in press as Bulletin 615.

SOUTH CAROLINA.

The folio describing the areal and economic geology of the Kings Mountain and Gaffney quadrangles, in South and North Carolina, has been nearly completed by D. B. Sterrett, although minor field examinations at certain points may be needed before the folio can be finished.

The upper Cretaceous formations of South Carolina are discussed in the report by L. W. Stephenson on the worms and mollusks of the deposits of this age in the Carolinas. This report, which is ready for transmission, has been prepared in cooperation with the Geological and Economic Survey of North Carolina, by which it will be published.

A monograph on the Pliocene and Miocene Foraminifera of the Atlantic Coastal Plain, by Joseph A. Cushman, has recently been submitted for publication.

A paper by L. W. Stephenson, entitled "A deep well at Charleston, S. C.," with a report on the mineralogy of the water by Chase Palmer, has been published as Professional Paper 90–H.

SOUTH DAKOTA.

The preparation of a report on the Upper Cambrian geology, Tertiary igneous rocks, and mineral resources of the Black Hills to accompany a quadruple folio covering the Deadwood, Rapids, Hermosa, and Harney Peak quadrangles was continued by Sidney Paige, who investigated the ore deposits of the region. By order of the Assistant Secretary of the Interior, Mr. Paige also examined certain mining claims in the Harney National Forest. The Paleozoic and younger sedimentary formations in these quadrangles are being described by N. H. Darton.

A field study of the stratigraphy of the Cretaceous and Eocene formations in the vicinity of Mobridge was made by T. W. Stanton for purposes of correlation.

TENNESSEE.

In the Waynesboro quadrangle, Tennessee, some additional field examinations necessary to the completion of a folio were made by H. D. Miser, in cooperation with the Tennessee Geological Survey.

An investigation of the outcrops of the Clinton iron ore in the Cumberland Gap, Jonesville, Maynardsville, Morristown, Briceville, and Kingston quadrangles was made by E. F. Burchard, also in cooperation with the State, for the purpose of including the descriptions and maps of these deposits in a bulletin on the red iron ores of eastern Tennessee, northeastern Alabama, and northwestern Georgia.

The report on the Ducktown copper deposits is well advanced. The history and the descriptions of formations and structures have been written by F. B. Laney, and the description of the ore deposits by W. H. Emmons, but Mr. Emmons's part has not yet been adjusted to the part contributed by Mr. Laney and to that to be added by Arthur Keith.

In order more satisfactorily to classify and correlate the Paleozoic formations in portions of the State, sections were studied and numerous collections of invertebrate fossils were made in the eastern regions by R. D. Mesler and in central Tennessee by George H. Girty, in cooperation with H. D. Miser.

A brief field examination of the black shales at a number of points in Tennessee was made by G. H. Ashley, in connection with his study of the problem of the oil and gas resources ultimately to be realized through the distillation of these richly carbonaceous and widespread deposits.

A report on the fossil flora of the Jackson group, which covers a portion of the State, is in preparation by E. W. Berry, who also described the lower Eocene flora in Professional Paper 91, now in press.

In connection with the study of the post-Tertiary history and the physiography of the Mississippi embayment area an examination of the physiography and Quaternary geology of western Tennessee is in progress by E. W. Shaw.

In accordance with a plan for cooperating with the Bureau of Mines, the Bureau of Standards, and the Office of Public Roads in the investigation of the building materials of the United States, T. Nelson Dale examined the marble deposits of eastern Tennessee. This investigation was made in cooperation also with the State geological survey, which is expected to furnish areal and stratigraphic details, the data respecting the mechanical composition and the special characteristics and qualities of the marbles to be prepared by Mr. Dale. Physical tests of samples submitted have been furnished by the Bureau of Standards. The preparation of Mr. Dale's report is well advanced.

The phosphate deposits in the vicinity of Mount Pleasant, the center of the brown rock phosphate industry in the State, have received some preliminary field study by W. C. Phalen, who has brought up to date the mapping of the important deposits of brown rock, sampled the deposits for analyses, and studied the conservation of these important resources. The results of these studies will probably be included in a general economic report on the phosphate deposits of the southern Appalachian region.

In accordance with a cooperative arrangement between the Bureau of Mines, the Tennessee Geological Survey, and the United States Geological Survey, all the coal mines in Tennessee producing coal on a commercial scale and a number of small and intermittently operated coal mines were examined and sampled by the Geological Survey, all the samples being taken by one geologist, Frank R. Clark. The sampling was done according to the practice of the Geological Survey and the Bureau of Mines, which made the analyses. The analyses will probably be published by this Survey, by the State, and by the Bureau of Mines.

TEXAS.

A reconnaissance of the deposits of brown iron ores and iron carbonate ores in northeastern Texas was made by E. F. Burchard, whose report on the iron ores of Cass, Marion, Morris, and Cherokee counties is in press as Bulletin 620–E.

In connection with the investigation of nonmetalliferous mineral deposits in various regions, the supposed phosphate deposits in Brewster County were examined by W. C. Phalen, in company with J. A. Udden, of the bureau of economic geology and technology of the University of Texas. Mr. Phalen also inspected the cores of drillings made in exploration for sulphur at Bryan Heights. Observations noted in connection with these examinations are incorporated in his report on the production of sulphur for 1914.

In the Survey's investigation of all reported discoveries of potash salts samples have been taken for analysis at a number of points in Texas. Close attention is given to all borings in the "Red Beds" region of the State, and this Survey has offered to supplement the work of the State University through the field observation of drilling and the analyses of samples.

The relations of the Fayette, Catahoula, and Fleming formations in Texas were studied by G. C. Matson and Alexander Deussen, and a report on the Catahoula formation, prepared by Mr. Matson in cooperation with E. W. Berry, was transmitted for publication. Reports on the fossil flora of the Claiborne and Jackson groups were being prepared by Mr. Berry.

The manuscript for a report on the geology of the Coastal Plain of Texas west of Brazos River, by Alexander Deussen, is nearing completion. The underground water supply of Lasalle and McMullen counties is discussed by Mr. Deussen and R. B. Dole in a report transmitted for publication by the water-resources branch (Water-Supply Paper 375–G).

Reconnaissance examinations, with special reference to the possible occurrence of oil or gas pools, were made by C. H. Wegemann, near Mineral Wells and Quanah, and reports containing the conclusions reached have been submitted for publication in the current volume of "Contributions to economic geology."

UTAH.

A general summary report on the ore deposits of Utah, by B. S. Butler and G. F. Loughlin, has been materially advanced during the year, and the authors expect to complete it during the coming year.

The Tintic district was revisited by Waldemar Lindgren and Mr. Loughlin to procure additional material for their report on the geology and ore deposits. This report has since been transmitted by the senior author for publication. Mr. Loughlin also made a brief visit to the Ophir district to study the occurrence of the zinc ores.

In response to a special request from mining men, Mr. Loughlin revisited Marysvale for the purpose of further examining the alunite deposits and later submitted a brief report. He also examined the ore deposits at Fortuna, near Beaver.

The search for uranium and vanadium deposits in southeastern Utah, begun by F. L. Hess but temporarily relinquished by him on account of illness, was continued by B. S. Butler, assisted by W. H. Whitehead, in Wayne, Garfield, and San Juan counties. In addition to examining the horizons at which uranium minerals are known to occur, the stratigraphy of the Colorado Plateau and Henry Mountains regions as interpreted by Dutton and Gilbert was reexamined, and correlations were made with areas farther north and east that had been mapped by C. T. Lupton and E. G. Woodruff.

A reconnaissance report on the Cottonwood-American Fork area by Messrs. Butler and Loughlin, with a section on the history of mining and production by V. C. Heikes, was submitted for publication (Bulletin 620–I).

The physiography and geologic history of the Colorado Plateau have been the subject of a general study by H. E. Gregory, which he expects to continue as opportunities arise and funds are available.

The occurrence of phosphate deposits in rocks of Mississippian age in the vicinity of Logan was investigated by E. H. Finch, whose report is in preparation.

A preliminary reconnaissance examination of the south and west slopes of the Uinta Mountains to determine whether or not phosphate is present and under what conditions it occurs was made by A. R. Schultz.

A brief examination of the salts in Salduro Salt Flat, with special reference to the possible presence of potash in commercial amounts, was made by Hoyt S. Gale.

The detailed survey begun in the Book Cliffs coal field at Sunnyside, Carbon County, in 1911, has been continued westward each succeeding year, and in the season of 1914 another 15-minute quadrangle, the Castle Gate, was covered. Nothing has yet been published on these areas, but an economic bulletin and a folio are in preparation for each quadrangle completed, namely, Sunnyside, Wellington, and Castle Gate. In this investigation the outcrop of each coal bed of economic value was traced and mapped by F. R. Clark, the geologist in charge, and many exact data were obtained regarding both horizontal and vertical locations of measured sections of the coal beds. In spite of the rugged character of the cliffs, which made the work difficult and laborious, an area of 230 square miles was examined in detail.

In addition to the Castle Gate quadrangle an area of about 80 square miles in Morgan County was examined in detailed reconnaissance by Mr. Clark to determine the possible occurrence of coal in commercial quantities. The land has been classified, and a short geologic report is now in preparation by Mr. Clark.

The ozokerite deposits near Colton, Soldier Summit, and Media were examined by H. M. Robinson, who has prepared and submitted for publication a report on the ozokerite deposits of Utah. The oil shale near Mount Pleasant was examined by Mr. Robinson in company with David T. Day, in cooperation with the Bureau of Mines.

A geologic report on the Emery coal field by C. T. Lupton has been submitted for publication, and a report on the Coalville coal field, by C. H. Wegemann, based on field work done in a previous year, has been published as Bulletin 581–E.

Some field observations of the ancient Lake Bonneville basin were made by G. K. Gilbert, in connection with his brief description of the history of the lake and of Great Salt Lake, for use in the Overland Route guidebook (Bulletin 612). In connection with the preparation of a discussion of the geologic structure in the Great Basin region, observations on the master faults associated with the mountain ranges were made by Mr. Gilbert.

VERMONT.

In the Bennington quadrangle, Vermont, detailed mapping was completed by L. M. Prindle. During this work Mr. Prindle was joined for a conference by Prof. G. H. Perkins, State geologist, and for a review of the work of Arthur Keith, who also discussed the geologic work of the Survey in Vermont with Prof. Perkins. Special investigation was made by Mr. Keith of the stratigraphy and faulted structure of the Taconic Mountains in the Brandon, Rutland, Castleton, Pawlet, and Wallingford quadrangles for the purpose of solving some intricate problems involved in this work before the southern Vermont folios can be submitted for publication. A brief reconnaissance was made by Mr. Keith in the Ludlow and Brattleboro quadrangles.

The mapping of the Quaternary deposits of the Hoosic and Bennington quadrangles was completed by F. B. Taylor, who has nearly finished the descriptions to be incorporated in a folio covering these quadrangles. The field examination of the Quaternary deposits of the Pawlet and Equinox quadrangles was begun by Mr. Taylor.

VIRGINIA.

The detailed investigation and mapping of the southwestern Virginia coal field was continued in cooperation with the Virginia State Geological Survey. The geologic field examinations, which were contemporaneous with the topographic mapping and conducted from the topographic camp, were extended over the Virginia portions of the Hurley, Gilbert, Matewan, Iaeger, and Welch quadrangles. This work was in charge of Henry Hinds, who was assisted on the part of the State by T. K. Harnsberger. Progress was made on the Bucu and Clintwood geologic maps. The pre-Pennsylvanian rocks of the Bucu quadrangle were examined by G. W. Stose in company with Mr. Hinds.

For the purpose of comparing and correlating several of the older geologic formations in the region under detailed investigation, Mr. Hinds made a brief reconnaissance, with E. O. Ulrich and Charles Butts, of the formations exposed near Roanoke and Cleveland.

The preparation of a report embodying the results of the study of the coals in the Pocono formation of Virginia, which were examined the previous spring, was begun by R. W. Howell. This work was done in cooperation with the State Geological Survey.

In the Abingdon quadrangle detailed areal work on the Paleozoic formations was continued by G. W. Stose, who will describe and map most of them in the Abingdon folio, for which the pre-Paleozoic rocks will be treated by Arthur Keith. Although this project is not cooperative, Mr. Stose was joined for a time by T. L. Watson, State geologist, who, with F. A. Wilder, of the State Survey, is cooperating with Mr. Stose in the preparation of reports on salt and gypsum in the State.

A number of sections of the Devonian formations in southwestern Virginia were visited by Charles Butts, E. O. Ulrich, and R. D. Mesler, for the purpose of correlating the formations in this region with those in other regions and States of the Appalachian province.

A monograph describing the Tertiary Mollusca of Virginia and North Carolina has been completed by Miss Julia Gardner.

Mica deposits in Amelia and Hanover counties and an amethyst deposit in Louisa County were examined by D. B. Sterrett.

WASHINGTON.

The Glacier coal field, in Whatcom County, Wash., was examined by M. R. Campbell for the purpose of classifying the land and valuing that which is underlain by workable coal. The report on this field, which was found to contain a considerable quantity of high-grade anthracite, has been delayed in the hope that additional prospecting would be done so as to afford fuller and more exact information relating to the coal.

Several small tracts near Molson were examined by E. L. Jones, jr., to ascertain their probable value for metal mining or agriculture. Mr. Jones also made a reconnaissance examination of about 100 square miles in the Conconully district.

A report describing the mineral deposits and geology of the Colville Indian Reservation, based on an examination made in previous seasons for purposes of classification, was submitted by J. T. Pardee for publication in "Contributions to economic geology."

WEST VIRGINIA.

Some progress has been made in the preparation of a report on the semianthracite coal resources of the Pocono formation, in West Virginia, by R. W. Howell, but further work was postponed on account of the detail of Mr. Howell for investigations in the Mid-Continent oil region.

An examination was made by G. H. Ashley of the black shale at a number of points in the State in connection with an investigation of the value of such shale for distillation.

The survey of the Williamsport quadrangle, including parts of Maryland and Pennsylvania, was completed by G. W. Stose, and the results will be published in the Williamsport-Hagerstown folio. Mr. Stose and G. P. Grimsley, of the State Survey, held a field conference in this area, the State Survey being interested in this work, although not cooperating financially.

WISCONSIN.

Special examinations of the glacial deposits of northwestern Wisconsin were made by Frank Leverett in October, 1914, and, together with Dr. Samuel Weidman, of the Wisconsin Geological and Natural History Survey, in June, 1915, in order to correlate the deposits in Minnesota with those in Wisconsin and to complete the data for a report on the extent and relations of the Superior ice lobe in Michigan, Wisconsin, and Minnesota.

An agreement has been made with Dr. Weidman for the completion of a folio covering the Wausau and Marathon quadrangles, in cooperation with the State Survey.

Some additions were made to the manuscript on the Quaternary geology of southeastern Wisconsin, which was submitted for publication by W. C. Alden.

In cooperation with the geologists of the State Survey the stratigraphy and paleontology of the early Paleozoic formations were investigated by E. O. Ulrich.

WYOMING.

The areal mapping and the investigations relating to the possibilities of the presence of oil and gas in the structural domes and anticlines of central Wyoming between Casper and Lander, in Natrona, Fremont, and Carbon counties, commenced in 1913, was completed by C. J. Hares, assisted by J. B. Reeside, jr., and K. C. Heald. An area of about 2,800 square miles was covered, of which 1,940 miles was mapped in detail and the remainder in detailed reconnaissance. Special attention was given to the structure of the rocks and to the late Tertiary formations. The total area mapped in the two seasons is about 5,000 square miles, upon which a short preliminary report has been submitted for publication, and a final report is now being prepared.

In the eastern portion of the Bighorn Basin a detailed geologic examination was begun by C. T. Lupton, assisted by J. D. Northrop and W. P. Woodring, special attention being given to the structure of the rocks in order to discover those structures which are favorable to the accumulation of oil and gas. A preliminary report entitled "Oil and gas near Basin, Big Horn County, Wyo." (Bulletin 621–L) and a more detailed report on oil fields in the southern part of the Bighorn Basin have been submitted by Mr. Lupton.

Field work was resumed by C. F. Bowen in the Saddleback quadrangle, forming part of an examination made primarily for the purpose of classifying and valuing the coal lands embraced in the Saddleback, Hanna, and Walcott quadrangles. Exact horizontal and vertical locations were determined by plane-table methods for all sections measured on the coal beds as well as for geologic boundaries and structural features. Economic and folio reports for the Saddleback quadrangle are being prepared by Mr. Bowen.

In the Ilo, Oregon Basin, and Meeteetse quadrangles field examinations were completed by D. F. Hewett, who has submitted for publication an economic report covering the two quadrangles last named and is also preparing folios for the area examined. The geologic mapping was done by plane-table methods and independently of the topographic sketching, which was carried on simultaneously by the topographic branch.

The survey of the central part of the Powder River coal field and the reexamination of the Salt Creek oil field were begun by C. H. Wegemann and R. W. Howell.

Reconnaissance examinations were made of ore deposits in the North Laramie Mountains and of the Atlantic gold district, in the southeastern part of the State, by A. C. Spencer, who has transmitted a report on the North Laramie Mountain region and has in preparation his report on the Atlantic district.

A field study of the Bighorn limestone as exposed in the Wind River Mountains near Lander, in the Owl Creek Mountains, and in the Bighorn Mountains was made by Edwin Kirk.

An examination for phosphate was made by G. R. Mansfield in the Salt River region east of Star Valley. Data for the classification of the land in seven townships have been submitted by Mr. Mansfield, who has completed, for publication as a bulletin, a report on the economic resources of the region.

A report of a reconnaissance in southeastern Idaho and western Wyoming, with special reference to phosphate deposits, was submitted by A. R. Schultz.

CANAL ZONE.

The investigations made for the purpose of determining the geologic formations, their correlation, and the geologic history of the Canal Zone and adjacent regions of Panama and Costa Rica have been continued during the year, and most of the series of reports planned with the cooperation of the Smithsonian Institution, the Isthmian Canal Commission, and the United States Geological Survey are approaching completion. A manuscript describing the physiography, stratigraphy, geologic structure, geologic history, and economic geology of the Canal Zone and adjacent areas, by D. F. MacDonald, is about one-third completed. A report on the fossil calcareous algæ of the Canal Zone has been submitted by Dr. M. A. Howe, of the New York Botanical Garden, and reports on the Foraminifera and on the fossil Crustacea have been completed by Joseph A. Cushman and Miss M. J. Rathbun, respectively. Progress has been made in the report on the fossil plants of higher orders by E. W. Berry, on the fossil corals by T. W. Vaughan, on the fossil echinoids by R. T. Jackson, and on the fossil Bryozoa by R. S. Bassler and F. Canu. This series of reports, which will contain important conclusions as to geologic correlation and geologic history, will be published by the Smithsonian Institution.

ANTILLES.

A series of reports similar to those relating to the Canal Zone is in preparation for the Lesser Antillean Islands. The materials, largely paleontologic, submitted for study and the opportunities for field examinations are occasional and are possible only through the courtesy of private citizens, local governments, or scientific institutions. The systematic investigations, which are under the direction of

T. W. Vaughan, have been made possible through grants by the Carnegie Institution of Washington. Most of the cooperating geologists and paleontologists are not officers of the United States Geological Survey, but, besides Mr. Vaughan, who is studying the general physiography and general geology and is describing the fossil corals, C. Wythe Cooke has already prepared a report on the fossil Mollusca from the Lesser Antillean Islands and from Cuba. A report on the Foraminifera is in preparation by Joseph A. Cushman.

The investigations relating to the Canal Zone and the Antilles are of great importance to the understanding of the geology of both the eastern and western sides of continental North America, as only by accurate paleontologic knowledge of the West Indies and Central America can the geologic formations and the fossil associations on the two sides of the continent be correlated.

HAWAII.

A report by Whitman Cross on the "Lavas of Hawaii and their relations" has been published as Professional Paper 88.

DIVISION OF ALASKAN MINERAL RESOURCES.

APPROPRIATION AND CLASSES OF WORK.

On April 6, 1914, $100,000 was appropriated for the continuation of the investigation of the mineral resources of Alaska. The availability of funds at this early date made it possible to start the field work promptly and to carry it on economically, and the results were in strong contrast to those of the two previous years, when the delay in granting funds until summer greatly hampered the field work and made it very expensive.

The work carried on under this appropriation, as in previous years, included reconnaissance and detailed geologic and topographic surveys, special investigations of mineral resources, and the collection of statistics on mineral production.

PERSONNEL.

On July 1, 1914, the personnel of the division consisted of 1 geologist in charge, 11 geologists, 4 topographers, 3 clerks and 1 draftsman on annual salaries, 2 field assistants, and 22 camp hands and recorders. On June 30, 1915, the personnel included 1 geologist in charge, 11 geologists, 4 topographers, 1 engineer, 3 clerks, and 1 draftsman on annual salaries, 1 clerk on monthly salary, 2 geologists on per diem salary, 1 field assistant, and 28 camp hands and recorders.

FIELD OPERATIONS DURING SEASON OF 1914.

Areas covered and allotments.—Ten parties were engaged in surveys and investigations during 1914. The area covered by exploratory geologic surveys, on a scale of 1: 500,000 (8 miles to the inch), amounts to 1,000 square miles; by reconnaissance geologic surveys, on a scale of 1: 250,000 (4 miles to the inch), 7,700 square miles; by detailed geologic surveys, on a scale of 1: 62,500 (1 mile to the inch), 325 square miles. Much of the time of the geologists was devoted to the investigation of special field problems in the important mining districts, the results of which can not be presented in terms of area. About 600 square miles was covered by exploratory topographic surveys on a scale of 1: 500,000, 10,300 square miles by reconnaissance topographic surveys on a scale of 1: 250,000, and 10 square miles on a scale of 1: 24,000 (2.64 inches to 1 mile).

The following table shows the allotment, including both field and office expenses, of the total appropriation to the districts investigated. In addition to this, a balance of about $6,000 from last year's appropriation was expended in equipping the parties for the season's field work. In preparing this table the general office expenses were divided among the districts in proportion determined by the cost of the surveys in each district, allowance being made for variations in the character of the work The results are expressed in round numbers. The "general investigations" include the cost of special studies of geology and mineral resources which were not of an areal character. The unallotted balance has been used for equipment of field parties and expenses up to the close of the fiscal year 1915.

Approximate geographic distribution of appropriation for Alaska investigations, 1914.

Southeastern Alaska	$6,000
Copper and Susitna basins	25,000
Prince William Sound	6,500
Kuskokwim and Mulchatna River basins	22,000
White and Chisana River basins	14,000
Yukon basin	2,000
Seward Peninsula	1,500
General field and office investigations	12,000
Allotted to field investigations of 1915	11,000
	100,000

In the following table the approximate amount of money devoted to each class of investigations and surveys is indicated. It is not possible to give the exact figures, as the same party or even the same man may have carried on two different kinds of work, but this statement will help to elucidate a later table, which will summarize the complete areal surveys.

Approximate allotments to different kinds of surveys and investigations, 1914.

Geologic and topographic exploration	$4,400
Geologic reconnaissance surveys	13,000
Detailed geologic surveys	15,600
Special geologic investigations	13,000
Reconnaissance topographic surveys	22,500
Detailed topographic surveys	4,300
Collection of statistics	1,400
Miscellaneous, including administration, inspection, clerical salaries, office supplies and equipment, and map compilation	14,800
Allotted to field investigations, 1915	11,000
	100,000

Allotment for salaries and field expenses, 1914.

Scientific and technical salaries	$36,530
Field expenses	36,715
Clerical and other office and miscellaneous expenses	15,755
Allotted to field investigations, 1915	11,000
	100,000

Progress of work.—The following table exhibits the progress of investigations in Alaska and the annual appropriations since systematic surveys were begun in 1898:

Progress of surveys in Alaska, 1898–1914.

Year.	Appropriation.	Areas covered by geologic surveys.			Areas covered by topographic surveys.[a]					Investigations of water resources.	
		Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000).	Detailed (scale 1:62,500).	Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000; 200-foot contours).	Detailed (scale 1:62,500 and larger; 25, 50, or 100 foot contours).	Lines of levels.	Bench marks set.	Gaging stations maintained part of year.	Measurements of stream volume.
		Sq. m.	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Miles.*			
1898	$46,189	9,500	.....	.....	12,840	2,070	.....	.....	.....	.....	.....
1899	25,000	6,000	.....	.....	8,690	.....	.....	.....	.....	.....	.....
1900	60,000	3,300	6,700	.....	630	11,150	.....	.....	.....	.....	.....
1901	60,000	6,200	5,800	.....	10,200	5,450	.....	.....	.....	.....	.....
1902	60,000	6,950	10,050	.....	8,330	11,970	96	.....	.....	.....	.....
1903	60,000	5,000	8,000	96	.....	15,000	.....	.....	.....	.....	.....
1904	60,000	4,050	3,500	.....	800	6,480	480	86	19	.....	.....
1905	80,000	4,000	4,100	536	.....	4,880	787	202	28	.....	.....
1906	80,000	5,000	4,000	421	.....	13,500	40	.....	.....	14	286
1907	80,000	2,600	1,400	442	.....	6,120	501	95	16	48	457
1908	80,000	2,000	2,850	604	.....	3,980	427	76	9	53	556
1909	90,000	6,100	5,500	450	6,190	5,170	444	.....	.....	81	703
1910	90,000	.....	8,635	321	.....	13,815	36	.....	.....	69	429
1911	100,000	8,000	10,550	496	.....	14,460	246	.....	.....	68	309
1912	90,000	.....	2,000	525	.....	.....	298	.....	.....	69	381
1913	100,000	3,500	2,960	180	3,400	2,535	287	.....	.....	24	185
1914	100,000	1,000	7,700	325	600	10,300	10	.....	.....	.....	.....
	1,261,189	73,200	83,735	4,396	51,680	126,880	3,652	450	72	.....	.....
Percentage of total area of Alaska		12.48	14.28	0.75	8.81	21.64	0.62	.....	.....	.....	.....

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[a] The Coast and Geodetic and International Boundary surveys and the General Land Office have also made topographic surveys in Alaska. The areas covered by these surveys are, of course, not included in these totals.

General work.—Alfred H. Brooks, geologist in charge, was engaged in office work until July 6, when he started for Alaska. He visited Survey parties at Juneau, Valdez, Kotsina River, and Fairbanks, returning to Washington October 7.

George C. Martin was engaged during the summer on the Mesozoic stratigraphy of Alaska. Mr. Martin, accompanied by R. M. Overbeck as assistant, visited important localities in southeastern Alaska and in the Chitina and Yukon valleys. Arthur Hollick was employed for 64 days in continuing the study of Alaska Cretaceous and Tertiary floras.

R. H. Sargent continued the general supervision of the topographic surveys and map compilation in addition to carrying on his own field work. E. M. Aten continued as office assistant to the geologist in charge and supervised the office work during the field season. He also continued to assist in collecting statistics of the production of precious metals in Alaska.

Southeastern Alaska.—D. C. Witherspoon worked on detailed topographic surveys in the Juneau district. Rain prevented work on 45 days and greatly hampered it much of the rest of the season. Nevertheless, Mr. Witherspoon covered the area by triangulation and mapped 9.75 square miles on a scale of 1 : 24,000, with 50-foot contours. Mr. Eakin devoted about 10 days in the fall to the study of mining developments in the Juneau and Berners Bay districts.

Copper River and Susitna basin.—Detailed geologic mapping of the west end of the Kotsina-Chitina copper belt, begun in 1912, but interrupted in 1913, was completed in 1914 by F. H. Moffit, assisted by J. B. Mertie, who together mapped the geology and studied the mineral resources of an area of 185 square miles.

A topographic reconnaissance survey was carried by J. W. Bagley from Copper Center to the head of Klutina River and thence northwestward to the Susitna, an area of 4,000 square miles being surveyed by phototopographic methods, on a scale of 1 : 250,000, with 200-foot contours. Theodore Chapin, who accompanied the party as geologist, mapped an area of about 3,600 square miles. He also examined the gold placers of the Nelchina basin. This survey is an important connecting link between areas previously mapped in the Copper, Susitna, and Matanuska valleys.

Prince William Sound.—A detailed geologic survey and study of mineral resources of the Port Valdez district was begun in 1914 by B. L. Johnson, assisted by G. L. Harrington, covering 140 square miles.

Lake Clark-Iditarod region.—An exploration of the large, almost unknown region lying between Lake Clark and the Iditarod district was undertaken in 1914 by a party under R. H. Sargent, topographic engineer, and P. S. Smith, geologist. The topographic surveys covered 4,800 miles and the geologic surveys 3,500 square miles. Some of the quicksilver deposits of the Kuskokwim region were also examined.

Lower Kuskokwim basin.—A. G. Maddren, assisted by Burt Kennedy, made a reconnaissance in the lower Kuskokwim basin. From Iditarod they went overland to Kuskokwim River, down that river, and up several tributary streams, making an examination of the Aniak-Tuluksak placer district and exploratory topographic surveys of about 600 square miles. Besides the gold placers, some copper and quicksilver deposits were examined.

Seward Peninsula.—In view of important developments in the York tin district a supplementary examination of this field was undertaken by H. M. Eakin, who also investigated the mining developments near Nome and made a brief study of the iron deposits in the Sinuk basin, about 40 miles from Nome.

Yukon basin.—Owing to the development of gold placers in the Chisana district in the upper Tanana Valley C. E. Giffin was detailed to extend the topographic surveys in this field. He surveyed Skolai Pass, extended the previous mapping in the Tanana and White River basins eastward to the international boundary, made reconnaissance surveys of about 1,500 square miles, for publication on a scale of 1: 250,000, and revised about 1,500 square miles of the old mapping. The wagon road from Willow Creek to Chitina, a distance of 40 miles, together with the adjacent country, was also surveyed in the autumn, making an additional area of revision of about 150 square miles. S. R. Capps made a study of the Chisana placer district and mapped the geology of an adjacent area of about 600 square miles.

H. M. Eakin devoted about three weeks to the investigation of the mining developments in the Hot Springs and Fairbanks districts.

FIELD AND OFFICE WORK FOR SEASON OF 1915.

Alfred H. Brooks will continue his general geologic investigations in different parts of Alaska. G. C. Martin will complete the preparation of a report on the Mesozoic stratigraphy of Alaska. A. G. Maddren will complete reports on the Kuskokwim region, the Yakataga region, and the international boundary region in northeastern Alaska. Arthur Hollick will continue work on a report on Cretaceous and Mesozoic floras. G. A. Waring is investigating the hot springs of Alaska and will also collect data on the quality of the surface waters. D. C. Witherspoon is continuing the preparation of a new base map of the Juneau district on a scale of 1: 24,000. The water powers of southeastern Alaska are being investigated by George H. Canfield, in cooperation with the Forest Service. Theodore Chapin is studying the geology and mineral resources of the Ketchikan district. A reconnaissance geologic survey and investigation of the mineral resources of the upper Chitina basin is being made by F. H. Moffit and R. M. Overbeck. B. L. Johnson is completing a detailed geologic survey and study of the mineral resources of the Port Valdez district. He will later extend a reconnaissance geologic survey in the Prince William Sound region. Topographic and geologic reconnaissance surveys and investigations of mineral resources are being made in the Knik and Turnagain Arm region by J. W. Bagley and S. R. Capps. Time permitting they will also make similar surveys north of the Willow Creek district. Eliot Blackwelder is engaged in studying the Paleozoic stratigraphy of the upper part of the Yukon basin in Alaska. Topographic reconnaissance surveys of the Ruby district and the region lying to the south as far as Kuskokwim River are being made by R. H. Sargent and C. E. Giffin, and the geology and mineral resources of the same region are being studied by J. B. Mertie and G. L. Harrington. H. M. Eakin will explore the region lying between Cosna River, tributary to the lower Tanana, and the Ruby district, on the Yukon.

COLLECTION OF STATISTICS.

The work of collecting statistics of the annual production of gold, silver, and copper, begun in 1905, was continued during the year. Preliminary estimates of mineral production were published on January 1, 1915. The progress report for 1914 (Bulletin 622), containing figures on mineral production, was transmitted in June. An abstract of this report, including the mineral statistics, was also transmitted in June for inclusion in the Survey's annual volume, Mineral Resources of the United States, for the calendar year 1914.

PUBLICATIONS.

During the year one professional paper (No. 87), three bulletins (Nos. 576, 578, 592), one water-supply paper (No. 342), and one separate of a water-supply paper (No. 345–F) relating to Alaska were issued.

Two Alaska maps were issued for sale—a general map of Alaska (scale 1:1,500,000) and a map of the Port Valdez district (scale 1:62,500).

Three bulletins (Nos. 605, 607, 608), one water-supply paper (No. 372), and one separate of a professional paper (No. 95-D) are in press. Manuscripts of the following reports have been completed: Mineral resources of Alaska, report on progress of investigations in 1914, by Alfred H. Brooks and others (Bulletin 622); the Yukon-Koyukuk region, Alaska, by H. M. Eakin; and the Chisana-White River district, Alaska, by S. R. Capps.

The following reports are in hand:

Geology of the Glacier Bay and Lituya region, Alaska, by F. E. Wright and C. W. Wright, including geologic reconnaissance map.

The Lake Clark-Iliamna region, Alaska, by P. S. Smith.

The Kotsina-Kuskulana district, Alaska, by F. H. Moffit.

The lower Kuskokwim region, Alaska, by A. G. Maddren.

The Nelchina-Susitna region, Alaska, by Theodore Chapin.

The Yakataga district, Alaska, by A. G. Maddren.

The upper Matanuska basin, Alaska, by G. C. Martin.

The Mesozoic stratigraphy of Alaska, by G. C. Martin.

Geology of the region along the international boundary, Alaska, from Porcupine River to the Arctic Ocean, by A. G. Maddren, including detailed geologic map.

The Cretaceous and Mesozoic floras of Alaska, by Arthur Hollick.

The office work on the three topographic maps named below, besides the three noted above as issued, were completed:

Broad Pass region, by J. W. Bagley; scale 1 : 250,000; contour interval 200 feet.

Matanuska Valley, by R. H. Sargent; scale 1 : 62,500; contour interval 100 feet.

Relief map of Alaska, compiled by J. H. Renshawe; scale 1 : 1,500,000.

The following maps are in hand:

Kotsina-Kuskulana district, by D. C. Witherspoon; scale 1:62,500; contour interval 100 feet.

Lake Clark-Iliamna region, by R. H. Sargent; scale 1:250,000; contour interval 200 feet.

Chisana-White River region, by C. E. Giffin; scale 1:250,000; contour interval 200 feet.

Nelchina-Susitna region, by J. W. Bagley; scale 1:250,000; contour interval 200 feet.

Juneau mining district, by D. C. Witherspoon; scale 1:24,000; contour interval 50 feet.

Lower Kuskokwim region, by A. G. Maddren; scale 1:500,000; contour interval 500 feet.

Yukon-Tanana region, compiled; scale 1:500,000; contour interval 500 feet.

SCIENTIFIC RESULTS.

Mr. Martin's investigations of the Mesozoic stratigraphy have shown that there is a wide development of Upper Triassic strata in southeastern Alaska, part of the supposed Carboniferous limestones having proved to be of Triassic age; that marine Upper Cretaceous rocks are well developed in the Chitina Valley, where no marine strata younger than the Jurassic had previously been recognized, and that the Upper Cretaceous plant-bearing beds extend up the Yukon Valley nearly to the Canadian boundary.

Mr. Maddren discovered some fossiliferous Upper Carboniferous limestones and tuffs on Kuskokwim River, many miles from any previously known Carboniferous rocks.

Mr. Capps has found a Devonian fauna in the older volcanic rocks of the Chisana district, apparently in the same general belt as the

Devonian locality discovered by Messrs. Moffit and Pogue at Broad Pass in 1913, though many miles distant. These two are the only known occurrence of Devonian rocks south of the Alaska Range, except in southeastern Alaska.

Mr. Capps discovered evidence of an older epoch of glaciation in the upper White River basin. Here there is an indurated tillite which has been more or less folded and antedates the glaciation that produced the present land forms. In the Lake Clark-Kuskokwim basin Mr. Smith found that the westward limit of glaciation was nearer the Kuskokwim than had been previously supposed. Mr. Maddren found evidence of a locally glaciated area in the mountains southeast of lower Kuskokwim River.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

This division is in charge of George F. Becker, geologist, who has immediate direction of geophysical researches. The staff in the chemical laboratory forms essentially a section in charge of F. W. Clarke, chief chemist.

The work of the chemists has consisted for the most part of routine analyses of specimens submitted to the division for determination. During the year 423 quantitative analyses and 869 qualitative determinations have been made. Nevertheless, it has been possible to carry on some researches connected with the geologic problems on which the Survey is engaged.

Continuing the investigation of the composition of the hard parts of various invertebrates living in the cold and in the warm waters of the seas, in order to ascertain the conditions under which magnesium carbonate is deposited in large amounts instead of calcium carbonate, analyses of the fossil remains of a number of brachiopods, corals, alcyonarians, and other marine animals were made by W. C. Wheeler under Mr. Clarke's direction. A paper by Mr. Clarke and Mr. Wheeler on the composition of the brachiopod shells was published in the Proceedings of the Washington Academy of Sciences. Another contribution giving the results of the analyses of the fan corals is now in preparation.

In addition to his administrative work in the laboratory, Mr. Clarke has revised and brought up to date the material for the third edition of "The data of geochemistry" (Bulletin 616). The second edition, published as Bulletin 491, was printed in 1911.

Some research work on the methods of separating vanadium from large quantities of chromium has been pursued by George Steiger, whose time, however, has been mostly taken up by routine analyses, the purchase of supplies, and other administrative duties.

In making analyses of rocks submitted by Survey geologists, R. C. Wells found that water from a mine near Idaho Springs, Colo., resembling ink in appearance, owed its color to the presence of nearly 8 grams of molybdenum oxide per liter; also that a rich gold ore from Goodsprings, Nev., was essentially a plumbojarosite, containing 0.22 per cent palladium and 0.05 per cent platinum. In separating salts from the water of Great Salt Lake, Mr. Wells found that in the interval between 0° and −1° C. the salt that separates is the mineral mirabilite, $Na_2SO_4.10H_2O$. A manuscript entitled "The fractional precipitation of some ore-forming compounds at moderate temperatures" was completed by Mr. Wells for publication as Bulletin 609.

As the result of his continued chemical studies of silver enrichment, Chase Palmer, who has been associated with Edson S. Bastin, of the division of geology, in the field investigations, published two papers—"Bornite as silver precipitant," in the Journal of the Washington Academy of Sciences, and "Tetranickel-triarsenide, its capacity as silver precipitant," in Economic Geology and in Zeitschrift für Krystallographie und Mineralogie. The research in silver enrichment, begun by the section of metalliferous deposits of the division of geology, is still in progress.

A report on the mineralogy of artesian well waters beneath Charleston, S. C., published in Professional Paper 90–H, contains a simplified statement by Mr. Palmer of the principles of the geochemical interpretation of water analyses. A part of Mr. Palmer's time has been given to routine quantitative and qualitative analyses of minerals and quantitative analyses of waters.

An extensive study of the vanadium minerals was made by W. T. Schaller. Analyses were made of several vanadium minerals from Utah and two new species from Peru, and of a new copper silicate from Arizona. Mr. Schaller also determined the optical properties of all the available gahnites. He made a field study of the granitic pegmatite intrusions near Pala, San Diego County, Cal., and of a reported occurrence of tin ore in the same county.

A number of analyses of phosphate rock and other miscellaneous analyses were made by W. C. Wheeler, whose work in association with Mr. Clarke has already been mentioned.

Special attention has been given by W. B. Hicks to the analyses of salts. Complete analyses were made of 13 brines, 3 salt samples, and 1 specimen of alunite, partial analyses of 80 samples, and qualitative examinations of about 85 samples. Mr. Hicks also carried on some experimental work on the solubility of minerals in solutions of ammonium chloride and on the evaporation of brines from Searles Lake, Cal. A paper on "Evaporation of potash brines" (Professional Paper 95–E) was submitted by him for publication by the Survey, and another on "Solubility of mixtures of sodium chloride and potassium chloride in solutions of hydrochloric acid" was published in the Journal of the American Chemical Society.

A great many miscellaneous analyses, including about 30 complete analyses of rocks, brines, salts, and waters, and 78 partial analyses of brines, muds, nitrates, and waters, were made by R. K. Bailey, who also gave one hour each day to assisting geologists in testing and identifying minerals. Some improvements in the apparatus and methods used in the laboratory for analytical work were devised by Mr. Bailey.

The work of the physical laboratory has consisted chiefly of the continuation of geophysical investigations noted in previous reports. In addition to his administrative work G. F. Becker carried on studies of isostasy, in connection with which he published in the Journal of the Washington Academy of Sciences a paper on the "Mean density of fractured rocks." The experimental data for this paper were determined by A. F. Melcher, and are described by him in a "Note on the change of density of sulphur with rupture," issued in the same publication. Mr. Melcher shows that some of the principal orogenic phenomena are due to decrease in the density of rocks under confinement through the production of cracks and to increase of density through infiltration. "Isostasy and radioactivity" was the subject of a presidential address by Mr. Becker before the Geological Society of America. In this address he drew the conclusions that not more than about a quarter of the heat emitted by the earth can be due to radioactivity and that the ages of minerals as determined by radiologists are untrustworthy. In this address and in a paper in the Proceedings of the National Academy of Sciences he concludes that the outer shell of the earth beneath continental areas is in fact an imperfect heat engine, which furnishes the energy manifested in upheaval, subsidence, and orogeny.

In consultation and cooperation with Prof. P. W. Bridgman, of Harvard University, Mr. Becker furnished hollow cylinders of rock-forming minerals for use in pressure tests. These Prof. Bridgman subjects to hydrostatic pressure of many thousand kilograms per square centimeter with highly interesting but at as yet incomplete results. Acknowledgments are due the Bureau of Standards for courteous cooperation in the preparation of these cylinders.

The conduction of heat out of an unevenly heated globe was investigated by Mr. Becker in the hope of elucidating conditions in high latitudes.

Work on the construction of mathematical tables, experiments on the diffusion of solids, and measurements of the temperatures of deep wells were continued by C. E. Van Orstrand, assisted by A. F. Melcher and A. T. Harris. Progress has been made in preparing a volume of tables of the probability integral and related functions adapted to the computation of diffusivities. An elaborate table of extended values of the exponential function and of the circular sine and cosine to radian argument is ready for publication.

In his experiments on the diffusion of solids Mr. Van Orstrand had the analytical cooperation of F. P. Dewey, of the Bureau of the Mint, United States Treasury. Some of the results of these experiments are to be published as Professional Paper 95–G, entitled "Preliminary report on the diffusion of solids." The experimental results confirm Roberts-Austen's values of the coefficients of diffusion of gold into solid lead at normal pressures and various temperatures. Preliminary experiments indicate an increase in the coefficient of diffusion with pressure. The results obtained at normal pressure from rolled plates and electroplates are remarkably consistent.

Measurements of the temperatures of two deep wells, one near Gaines, Pa., depth 5,500 feet, the other near McDonald, Pa., depth 7,000 feet, were made during the year by Mr. Van Orstrand. Determinations of the temperature of a well near Mannington, W. Va., about 3,000 feet deep, were made recently with an electrical resistance thermometer equipment specially designed by him for use in deep wells.

A paper on the "Calculation and comparison of mineral analyses," by Mr. Van Orstrand and F. E. Wright, of the Carnegie Institution, was published in the Journal of the Washington Academy of Sciences.

DIVISION OF MINERAL RESOURCES.

The scope of the work of the division of mineral resources has been the same as in recent years, the Survey having continued the policy of making the annual "Mineral Resources of the United States" more than a statistical compilation by recording and interpreting industrial progress and by treating in full the sources from which the mineral products of the country are obtained. This report thus becomes in fact, as well as in name, an annual inventory of the Nation's mineral resources.

During the last 12 years the separate chapters have been prepared in large part by geologists of the Survey who have specialized in the subjects treated, with a view to carrying out the provision of the organic act of the Survey which directs the examination of the mineral resources and products of the national domain.

Cooperation between the Geological Survey and the State surveys in collecting most of the mineral statistics continued in force in the preparation of the report for 1914. The 16 States which cooperated were Alabama, Florida, Illinois, Iowa, Maryland, Minnesota, Michigan, Missouri, New Jersey, New Mexico, North Carolina, Oregon, Pennsylvania, Virginia, Washington, and Wisconsin. The method em-
ˈɔyed obviates the duplication of a considerable amount of work

and, so far as applied, saves the producers the annoyance of preparing two sets of statistical returns.

During the fiscal year the report for 1913 was published in two parts—Part I (metals) in January and Part II (nonmetals) in February. Work on the report for 1914 was well advanced at the close of the year, 20 chapters having been completed and transmitted to the printer.

After the outbreak of the European war interest rapidly increased in the foreign supplies of mineral products needed in this country and also in domestic resources to supplant products hitherto imported and to fill war demands. A number of statements covering these subjects were immediately prepared for the press, and the division has carried on a large correspondence, furnishing to inquirers detailed information in regard to our mineral resources which could not be covered in general publications, such as locations of deposits of minerals wanted and names and addresses of producers.

Preliminary estimates of the production of arsenic, cement, coal, copper, gold and silver, iron ores, lead, petroleum, quicksilver, radium ores, rutile, tungsten ores, uranium ores, vanadium ores, western metals, and zinc in 1914, with reviews of the conditions that prevailed during the year, were given to the press in the form of special press bulletins during the later part of December, 1914, and in January, 1915. Advance statements giving the final figures covering the production of copper, lead, and zinc in 1914 have also been published.

The number of permanent employees in Washington who devote their entire time to the work of the division of mineral resources is 31, and 8 persons are employed in the offices of the division at Salt Lake City, Denver, and San Francisco. In addition to these employees, 21 members of other divisions of the Survey, chiefly geologists, devote a part of their time to the work of the division, making a total of 60 persons employed in the work.

During the year 192,673 pieces of first-class mail matter (chiefly inquiries for information needed for the reports, but including also, in increasing quantity, replies to inquiries made to the Survey for information) were sent out by the division, an increase of 2 per cent over 1914, and 65,401 pieces were received.

E. W. Parker continued as administrative head of the division and chief of the section of nonmetallic resources. On May 1 he tendered his resignation, to take a responsible position with the anthracite-coal interests. Mr. Parker's departure is a real loss to the United States Geological Survey. As the coal statistician of the Government since 1890, and as chief of the division since 1907, his contribution to the present standard of "Mineral Resources" has been large and important. He has also done valuable work in his studies of coal testing and conservation and has published in the engineering press many papers on coal mining and production. It is fortunate that in his new field Mr. Parker will continue his work on these subjects, on which he has long been regarded an authority.

Mr. Parker's resignation became effective July 1, and H. D. McCaskey, geologist in charge of the metals section of the division, became geologist in charge of the division. Mr. McCaskey brings to his new position experience not only as a geologist of the Survey since 1907 and as section chief since 1912, but also as a mining engineer in the Philippine mining bureau from 1900 to 1903 and as chief of that bureau from 1903 to 1906.

C. E. Lesher, a geologist of the Survey, who has had extensive field and office experience and for two years and a half was vice chairman of the coal board of the land-classification board, succeeds Mr. Parker in the work on coal and coke.

On August 31 David T. Day, who for 21 years was chief of the division and for seven years was in charge of the preparation of reports on asphalt and bituminous rock, natural gas, petroleum, and platinum and allied metals, resigned. Dr. Day had taken large part in the constructive administration of the division, and his separation from the service removes another man of broad experience. John D. Northrop, a geologist of the Survey who has become familiar with the general trend of the petroleum industry by many years in geologic work in the oil fields of the United States, has taken up the work on asphalt and bituminous rock, petroleum, and natural gas.

During the year Mr. Parker prepared for publication by the Survey the report on the fuel-briquetting industry and a general review of the mineral products of the United States. The reports on the several mineral products were in charge of the following persons:

Authors of chapters in Mineral Resources.

Author.	Subject.
E. S. Bastin	Graphite.
E. F. Burchard	Cement, fluorspar and cryolite, iron ore, pig iron, and steel.
B. S. Butler	Copper (general report), copper and silver in Michigan (mines report).
A. T. Coons	Slate.
C. A. Davis (of the Bureau of Mines).	Peat.
J. S. Diller	Asbestos, chromite, talc, and soapstone.
R. B. Dole	Mineral waters.
J. P. Dunlop	Silver, copper, lead, and zinc in the Central States, except Michigan (mines report); secondary metals, metals and ores (summary report), gold, silver, copper, lead, and zinc in the Eastern States (mines report), quicksilver.
H. S. Gale	Borax, magnesite (with C. G. Yale), nitrates.
C. N. Gerry	Gold, silver, copper, lead, and zinc in Idaho and Washington (mines report).
V. C. Heikes	Gold, silver, copper, lead, and zinc in Arizona, Montana, Nevada, and Utah (mines report).
C. W. Henderson	Gold, silver, copper, lead, and zinc in Colorado, New Mexico, South Dakota, Texas, and Wyoming (mines report).
F. L. Hess	Antimony, arsenic, bismuth, cobalt, molybdenum, nickel, selenium, tantalum, tungsten, titanium, vanadium, uranium, tin.
D. F. Hewett	Manganese and manganiferous ores.
J. M. Hill	Barytes, mineral paints, platinum and allied metals, strontium ore.
F. J. Katz	Abrasives, feldspar, silica (quartz).
C. E. Lesher	Coal, and the manufacture of coke.

Authors of chapters in Mineral Resources—Continued.

Author.	Subject.
H. D. McCaskey	Gold and silver (general report), summary of mineral products, quicksilver.
Jefferson Middleton	Clay, clay-working industries, fuller's earth, sand-lime brick.
J. D. Northrop	Asphalt and bituminous rock, natural gas, petroleum.
W. C. Phalen	Bauxite and aluminum, phosphate rock, potash salts, salt and bromine, sodium salts, sulphur and pyrite.
C. E. Siebenthal	Lead, zinc, and cadmium (general reports).
D. B. Sterrett	Gems and precious stones, mica.
G. F. Loughlin	Building stone, glass sand, other sand and gravel, gypsum, lime.
C. G. Yale	Borax, magnesite (with H. S. Gale), gold, silver, copper, lead, and zinc in California and Oregon (mines report).

Mr. McCaskey also has general supervision of the offices of the division in the Western States. These offices act as Survey bureaus of information and are under the direct charge of C. W. Henderson, V. C. Heikes, and C. G. Yale, who also prepare the mines reports on gold, silver, copper, lead, and zinc in the Western States.

TOPOGRAPHIC BRANCH.

ORGANIZATION.

The organization of the topographic branch is as follows:

Chief geographer, R. B. Marshall.
Atlantic division, Frank Sutton, geographer in charge.
Central division, W. H. Herron, geographer in charge.
Rocky Mountain division, Sledge Tatum, geographer in charge.
Northwestern division, T. G. Gerdine, geographer in charge.
Pacific division, G. R. Davis, geographer in charge.
Inspectors of topography, J. H. Renshawe, geographer; W. M. Beaman and A. M. Walker, topographic engineers.

PERSONNEL.

The technical corps of the topographic branch was reduced 7 during the year by death and by resignations. With these changes the corps now includes 1 chief geographer, 9 geographers, 40 topographic engineers, 18 topographers, 41 assistant topographers, 42 junior topographers, and 8 draftsmen—a total of 159. In addition, 37 technical field assistants were employed during a whole or part of the field season. One topographic engineer, 1 topographer, 3 assistant topographers, 6 junior topographers, and 1 draftsman are on furlough. The clerical force comprises 1 senior clerk and 11 clerks of lower grades.

PUBLICATIONS.

The published work of the topographic branch for the year consists of 107 maps, which are listed on pages 36–37, and 11 book publications, namely, "Topographic instructions of the United States Geological Survey," edition of 1915, and bulletins giving results of spirit leveling in Hawaii, Idaho, Iowa, Maryland, Michigan, Minnesota, Nebraska, Utah, Virginia, and Wisconsin. Brief summaries of these bulletins are given on page 21. Manuscripts for results of triangulation and primary traverse in the United States, 1913–1915, and of leveling in Arkansas, Georgia, Louisiana, Maine, Mississippi, New Mexico, South Dakota, Texas, and West Virginia were transmitted for publication.

ALLOTMENTS.

The total appropriations for topographic surveys for the fiscal year 1915 were:

Topographic surveys	$350,000
Surveying national forests	75,000
Statutory salaries	9,200
	434,200

The allotments of the appropriations, which were adhered to so far as practicable, were as follows:

Allotments from funds appropriated for topographic work, fiscal year 1915.

	Topographic surveys.	Surveying national forests.
Administrative expenses of Survey	$22,896	$4,500
Clerical assistance and supervision	15,670	3,210
Map editing	6,225	1,275
Purchase and repair of instruments, stationery, etc	12,242	2,508
Millionth-scale map	20,000	
Field work:		
Atlantic division	66,000	
Central division	53,000	
Rocky Mountain division	63,922	19,745
Northwestern division	36,000	26,462
Pacific division	54,045	15,000
Work by land-classification board	9,000	2,500
	359,000	75,200

COOPERATION.

Cooperation has been maintained with several States, as indicated below.

Allotments made by States for cooperative work.

Alabama	$3,032.78
California (Department of Engineering)	14,000.00
Illinois	9,000.00
Iowa	1,950.00
Kentucky	10,000.00
Maine	4,000.00
Michigan	2,500.00
Minnesota	4,500.00
Missouri	5,221.74
New York	10,000.00

Ohio	$35,000.00
Oklahoma	1,000.00
Oregon	18,000.00
Pennsylvania	4,000.00
Texas	35,000.00
Vermont	2,000.00
Virginia	4,500.00
Washington	11,500.00
West Virginia	6,758.20
Wisconsin	4,000.00
Hawaii	837.35
	186,800.07

In addition to the amounts given above, the State of Virginia allotted $485 to cover one-half the cost of the compilation of the Virginia portion of the 1:1,000,000 scale map of the United States, and the city of Los Angeles, Cal., allotted $2,500 for one-half the cost of the topographic survey of the Elizabeth Lake quadrangle.

GENERAL OFFICE WORK.

Progress maps were kept up to date and new ones were compiled when necessary, the new 1:500,000 State maps were used when available, and results of computations for vertical and horizontal control work were copied and catalogued.

The computations of control data were made principally by D. H. Baldwin, T. M. Bannon, C. E. Cooke, J. R. Ellis, G. T. Hawkins, Oscar Jones, C. B. Kendall, F. J. McMaugh, A. C. Roberts, J. H. Wilson, Fred McLaughlin, J. F. McBeth, and J. I. Gayetty under the immediate supervision of E. M. Douglas, geographer. Computing by L. F. Biggs and C. F. Urquhart was done in the Sacramento office. S. S. Gannett, geographer, was engaged in preparing manuscript and compiling data for the bulletins submitted for publication, in miscellaneous computations, and in furnishing triangulation and leveling data for field and office use.

J. H. Renshawe was engaged during a portion of the time in preparing for the Secretary of the Interior colored relief maps of Mount Rainier, Mesa Verde, and Rocky Mountain national parks. He also prepared a colored relief map of San Francisco and vicinity, a relief map of Alaska for the division of Alaskan mineral resources, and a small model to show the Survey's work for use in preparing a large model for the exhibition at San Francisco.

In the preparation of the special topographic maps used in the four transcontinental guidebooks the available Survey atlas sheets were used, and where such sheets were not available the data were filled in on field sheets on a scale of 5 miles to the inch. The different railroads assisted in every way possible, supplying all available profile and alignment data and rendering other valuable assistance. The maps were published on a scale of 1:500,000, or about 8 mi the inch, and cover routes as follows:

The Northern Pacific Route, over the Northern Pacific Railway from S Minn., to Seattle, Wash., with a branch from Livingston to Gardiner, Mont., north entrance to Yellowstone National Park (Bulletin 611).

The Overland Route, over the Union Pacific and Southern Pacific railro Omaha, Nebr., to San Francisco, with a branch from Ogden, Utah, over the Short Line, to the west entrance to Yellowstone National Park (Bulletin 612)

The Santa Fe Route, over the Atchison, Topeka & Santa Fe Railway from City, Mo., to Los Angeles, Cal., with a branch from Williams, Ariz., to the Canyon (Bulletin 613).

The Shasta Route, over the Northern Pacific and Southern Pacific railro Seattle, Wash., to San Francisco, and the Coast Line, over the Southern Pacif road from Los Angeles to San Francisco (Bulletin 614).

SUMMARY OF RESULTS.

The condition of topographic surveys to June 30, 1915, guished as to scale, etc., is shown on Plate II.

As shown in the following tables, the total new area mappe 20,508 square miles, making the total area surveyed to date United States 1,218,290 square miles, or 40.2 per cent of the country. In addition, 3,048 square miles of resurvey was com making the total area of surveys during the year 23,556 square

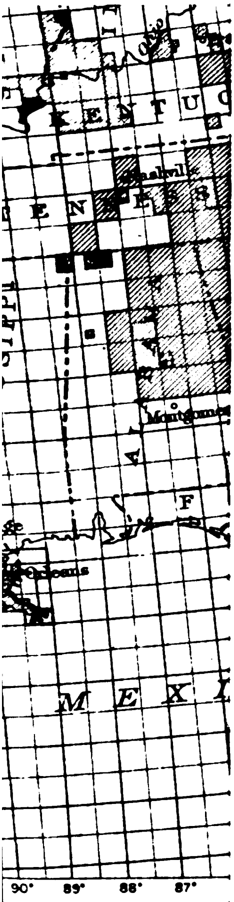
In connection with these surveys, 6,952 linear miles of p and precise levels were run, making 254,359 miles of primar precise levels run since the authorization of this work by Cong 1896. In the course of this work, 1,747 permanent bench were established. In addition, 498 linear miles of river survey run.

Triangulation stations to the number of 252 were occupied a were permanently marked. Primary traverse lines aggregating miles were run, in connection with which 356 permanent mark set. In the course of this work 32,400 square miles were cove primary control.

The area covered by topographic surveys in Alaska durin fiscal year, as reported in detail on page 93, was 10,910 square

Topographic surveys were also carried on in Hawaii, the mapped during the fiscal year being 19 square miles, for public on the scale of 1:31,680, making the total area surveyed to d Hawaii 1,393 square miles.

The average cost per square mile of the work done was $2 cost ranging from a little less than $4 in the Elizabeth Lake quadrangle to over $227 on the Sabine River project, Texas. per cent of the funds was expended in the public-land States.


K E N T U C
Nashville
T E N N E S S
Montgomery
F
New Orleans
M E X
90°
89°
88°
87°

SURVEYS P

Present condition of topographic surveys of the United States and new areas surveyed July 1, 1914, to June 30, 1915.

	New area mapped July 1, 1914, to June 30, 1915.	Total area mapped to June 30, 1915.	Percentage of total area of State mapped to June 30, 1915.
	Sq. miles.	*Sq. miles.*	
Alabama	440	19,192	37
Arisona	932	68,996	61
Arkansas		21,380	40
California	3,592	114,708	72
Colorado	1,439	48,783	47
Connecticut		4,965	100
Delaware		1,202	51
District of Columbia		70	100
Florida	259	2,339	4
Georgia		17,337	29
Idaho	687	26,185	31
Illinois	539	14,551	26
Indiana	191	3,441	9
Iowa	119	11,652	21
Kansas		64,159	78
Kentucky		17,973	44
Louisiana	8	8,319	17
Maine	151	9,361	28
Maryland		12,327	100
Massachusetts		8,266	100
Michigan	273	6,018	10
Minnesota	454	6,541	8
Mississippi	237	2,126	4
Missouri	544	36,710	53
Montana	557	57,163	39
Nebraska		26,524	34
Nevada	53	51,115	46
New Hampshire		3,380	36
New Jersey		8,224	100
New Mexico	1,315	37,247	30
New York	613	43,553	89
North Carolina	82	18,390	35
North Dakota		9,716	14
Ohio	2,818	40,018	97
Oklahoma	83	39,851	57
Oregon	1,771	23,406	24
Pennsylvania	262	24,908	55
Rhode Island		1,248	100
South Carolina		5,640	18
South Dakota		18,594	24
Tennessee		21,153	50
Texas	99	67,782	25
Utah	507	68,797	81
Vermont	224	4,190	44
Virginia		29,980	70
Washington	1,432	26,033	38
West Virginia		24,170	100
Wisconsin	270	12,203	21
Wyoming	557	28,404	29
	20,508	1,218,290	40.2
Hawaii	19	1,393	22

ATLANTIC DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Alabama, Florida, Georgia, Maine, Mississippi, New York, North Carolina, Pennsylvania, Tennessee, Vermont, Virginia, and West Virginia, and in a small area in Arkansas. This work comprised the completion of the survey of 11 quadrangles and of the resurvey of 5 quadrangles, in addition to which 7 quadrangles were partly surveyed and 7 were partly resurveyed. The total new area mapped was 2,276 square miles, for publication on the scale 1 : 62,500. The area resurveyed was 1,083 square miles, for publication on the scale of 1 : 62,500. The map of one quadrangle wa partly revised, the area covered by this revision being 13 square miles. In connection with this work 1,268 miles of primary levels were run and 332 permanent bench marks were established.

Primary triangulation and primary traverse were carried on at different times by seven parties, the work being distributed over portions of Louisiana, Maryland, New York, and West Virginia. The total area covered by this primary control was about 2,200 square miles—1,000 square miles by primary traverse, 336 miles being run and 36 permanent marks set. Twenty-four triangulation stations were occupied and 4 were permanently marked. This work made control available in 17 quadrangles.

Topographic surveys in Atlantic division from July 1, 1914, to June 30, 1915.

State.	Contour interval.	For publication on scale of 1 : 62,500.		Total area surveyed.	Primary levels.		Primary traverse.		Triangulation.	
		New.	Resurvey.		Distance run.	Bench marks.	Distance run.	Permanent marks.	Stations occupied.	Stations marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Alabama	20	440	99	539	144	36	....	....	....	....
Arkansas	....	....	....	....	42	3	....	....	....	....
Florida	20	259	....	259	....	....	....	....	....	....
Georgia	50	....	38	38	....	....	....	....	....	....
Louisiana	10	8	....	8	55	13	86	12	....	....
Maine	20	151	163	314	15	3	....	....	....	....
Maryland	....	....	....	....	....	....	34	2	....	....
Mississippi	10	237	....	237	116	34	....	....	....	....
New York	20	613	....	613	443	116	117	12	9	4
North Carolina	20	82	....	82	....	....	....	....	....	....
Pennsylvania	20	262	....	262	114	44	....	....	....	....
Tennessee	....	....	....	....	56	5	....	....	....	....
Vermont	20	224	....	224	67	17	....	....	....	....
Virginia	50	....	317	317	101	27	....	....	....	....
West Virginia	20	....	466	466	115	34	99	10	15	....
		2,276	1,083	3,359	1,268	332	336	36	24	4

Alabama.—As stated in the previous annual report, the State geologist of Alabama allotted $10,000 to cover the cost of unfinished cooperative work done in 1911–12, when under a cooperative agreement to spend $10,000 each $7,024.93 was expended by the Federal Survey and nothing by the State, whose funds were not available. During the year, after $3,032.78 had been expended, State cooperation ceased and the work was completed with Federal funds amounting to $5,932.15. The survey of the Muscle Shoals and Center Star quadrangles in Colbert, Lauderdale, and Lawrence counties, was completed, and that of the Gravelly Springs quadrangle, in Lauderdale County, was begun by C. E. Cooke, W. H. S. Morey, T. F. Slaughter, C. S. Wells, F. W. Crisp, and R. H. Kilmer, the area mapped being

440 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of the Center Star quadrangle Mr. Kilmer ran 66 miles of primary levels and established 17 permanent bench marks.

In addition to the cooperative work the resurvey of the Weogufka quadrangle in Coosa, Shelby, and Talladega counties was commenced by Duncan Hannegan, W. H. Griffin, W. H. S. Morey, J. B. Metcalfe, jr., C. S. Wells, and C. W. Arnold, the area mapped being 99 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of this area H. S. Senseney ran 78 miles of primary levels and established 19 permanent bench marks.

Arkansas.—(See Tennessee-Arkansas, p. 113.)

District of Columbia-Maryland-Virginia.—During the year the culture on the map of Washington and vicinity was revised in the field. In connection with this work C. B. Kendall and C. A. Ecklund ran 34 miles of primary traverse and set two permanent marks.

Florida.—The survey of the Interlachen quadrangle, in Marion and Putnam counties, was completed by W. H. Griffin, J. B. Metcalfe, jr., and C. W. Arnold, the area mapped being 259 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet.

Georgia.—The resurvey of the Talking Rock quadrangle, in Gilmer, Gordon, Murray, and Pickens counties, was completed by E. I. Ireland, K. W. Trimble, and H. S. Senseney, the area mapped being 38 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 50 feet.

Louisiana.—For the control of the Blanchard quadrangle, in Bossier and Caddo parishes, C. S. Wells and F. W. Crisp ran 86 miles of primary traverse and set 12 permanent marks and also ran 55 miles of primary levels and established 13 permanent bench marks. (See also Mississippi-Louisiana, p. 112.)

Maine.—For the continuation of cooperative topographic surveys in Maine the State Water Storage Commission allotted $4,000, which was met by the United States Geological Survey with an equal amount. The survey of the Liberty quadrangle, in Kennebec, Knox, Lincoln, and Waldo counties, was completed, and that of the Belfast quadrangle, in Knox and Waldo counties, was begun by W. H. Griffin, Duncan Hannegan, K. E. Schlachter, C. H. Davey, and E. W. Bowler, the total area mapped being 151 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of the Belfast quadrangle Mr. Schlachter ran 15 miles of primary levels and established 3 permanent marks.

In addition to the cooperative work in Maine, the resurvey of the Portland and Casco Bay quadrangles, in Cumberland and York counties, was completed by Hersey Munroe, R. A. Kiger, and K. F. Maxcy, the area mapped being 163 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet.

Mississippi-Louisiana.—The survey of the Vicksburg quadrangle, in Issaquena and Warren counties, Miss., and Madison Parish, La., was continued by C. E. Cooke, W. H. S. Morey, C. S. Wells, and F. W. Crisp, the area mapped being 245 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 10 feet. Of this area 8 square miles is in Louisiana. For the control of this area and of the Natchez quadrangle, in Adams and Jefferson counties, Miss., and Concordia Parish, La., H. S. Senseney and R. H. Kilmer ran 116 miles of primary levels and established 34 permanent bench marks.

New York.—The State engineer and surveyor of New York allotted $10,000 for the continuation of cooperative topographic surveys in that State, and the United States Geological Survey allotted an equal amount. The survey of the Canaseraga and Malone quadrangles, in Allegany, Franklin, and Livingston counties, was completed, and that of the Edwards, Hornell, and Moira quadrangles, in Allegany, Franklin, Livingston, Steuben, and St. Lawrence counties, was begun by G. S. Smith, Hersey Munroe, Robert Muldrow, R. C. McKinney, J. M. Whitman, A. P. Meade, jr., T. F. Slaughter, H. L. Dodge, and C. H. Davey, the area mapped being 613 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. In connection with the mapping of these areas and of the Andes, Oswegatchie, Long Eddy, Walton, Sidney, and Oneonta quadrangles, in Delaware, Chenango, Herkimer, Lewis, Otsego, and St. Lawrence counties, A. P. Meade, jr., K. E. Schlachter, H. S. Senseney, A. J. Kavanagh, and F. L. Shalibo ran 422 miles of primary levels and established 114 permanent bench marks. For the control of the Malone, Edwards, and Moira quadrangles G. T. Hawkins ran 117 miles of primary traverse and set 12 permanent marks, and for the control of the Oneonta and Sidney quadrangles, in Chenango, Delaware, and Otsego counties, Mr. Hawkins occupied 6 triangulation stations and marked 4.

In addition to the cooperative work, Mr. Hawkins and F. J. McMaugh occupied 3 triangulation stations in the John Boyd Thatcher Park, in Albany County, and ran 21 miles of primary levels and established 2 permanent bench marks in the Altamont Park, Albany County.

North Carolina.—The survey of the Gastonia quadrangle, in Gaston, Lincoln, and Mecklenberg counties, was completed by G. S. Smith, J. M. Whitman, J. H. Le Feaver, and Roscoe Reeves, the area mapped being 82 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet.

Pennsylvania.—The Topographic and Geologic Survey Commission of Pennsylvania allotted $4,000 for the continuation of the cooperative topographic survey of the State, and the United States Geological Survey allotted an equal amount. The survey of the Windber and Windgap quadrangles, in Bedford, Cambria, Carbon, Monroe, Northampton, and Somerset counties, was completed by Robert Muldrow, Oscar Jones, R. A. Kiger, J. B. Metcalfe, jr., E. D. Monroe, and C. E. Mills, the area mapped being 262 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of the Windgap quadrangle and of the Stahlstown quadrangle, in Fayette, Somerset, and Westmoreland counties, C. E. Mills ran 114 miles of primary levels and established 44 permanent bench marks.

In addition to the cooperative work the revision of part of the map of the Houtzdale quadrangle, in Clearfield and Center counties, was commenced by J. I. Gayetty, the area covered being 13 square miles.

Tennessee-Arkansas.—For the control of the Memphis quadrangle, in Shelby County, Tenn., and Crittenden County, Ark., F. W. Crisp and Kostka Mudd ran 98 miles of primary traverse and set 8 permanent marks, of which 42 miles and 3 marks were in Arkansas.

Vermont.—For the continuation of cooperative topographic surveys in the State of Vermont the governor allotted $2,000 and the United States Geological Survey allotted an equal amount. The survey of the St. Albans quadrangle, in Franklin and Grand Isle counties, was completed by Duncan Hannegan and J. F. McBeth, the area mapped being 224 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. In connection with this work K. E. Schlachter ran 67 miles of primary levels and established 17 permanent bench marks. The cooperative funds being insufficient to cover the completion of the St. Albans sheet, the additional expenses were borne by the Federal Survey.

Virginia.—For the continuation of cooperative topographic surveys in Virginia the State geologist allotted $4,500 and the United States Geological Survey allotted an equal amount. The resurvey of the Bucu quadrangle and of the Virginia portions of the Hurley and Iaeger quadrangles, in Buchanan, Dickinson, and Russell counties, was completed, and that of the Richlands quadrangle, in Buchanan, Russell, and Tazewell counties, was begun by J. I. Gayetty, C. W. Arnold, F. W. Farnsworth, and Kostka Mudd, the area mapped being 316 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 50 feet. For the control of these areas Mr. Mudd ran 101 miles of primary levels and established 27 permanent bench marks. (See also West Virginia, below.)

West Virginia.—In the continuation of cooperative topographic surveys in West Virginia the State geologist expended $6,758.20 and the United States Geological Survey $1,507.49. A resurvey of the West Virginia portions of the Martinsburg, Berryville, and Gerrardstown quadrangles and of the Morgan County portion of the Capon Bridge quadrangle was completed by E. I. Ireland, Hersey Munroe, T. F. Slaughter, K. W. Trimble, and C. W. Arnold, the area mapped being 467 square miles, for publication of the scale of 1 : 62,500, with a contour interval of 20 feet. Of this area 1 square mile is in Virginia. This work completed the mapping of Berkeley, Jefferson, and Morgan counties on the scale of 1 : 62,500. In connection with this work G. T. Hawkins and J. B. Metcalfe, jr., ran 99 miles of primary traverse and set 10 permanent marks, and K. W. Trimble and H. S. Senseney ran 115 miles of primary levels and established 34 permanent bench marks.

For the control of portions of the Webster Springs, Cowen, Richwood, Winona, and Summersville quadrangles Oscar Jones occupied 15 triangulation stations. This work was done to control those portions of Nicholas and Webster counties not yet mapped on the scale of 1 : 62,500.

OFFICE WORK.

The drafting of the following sheets was completed: Muscle Shoals and Center Star, Ala.; Talking Rock, Ga.; Casco Bay, Liberty, and Portland, Maine; Canaseraga, N. Y.; Belhaven, Gastonia, and Kinston, N. C.; Windber and Windgap, Pa.; Murfreesboro, Tenn.; St. Albans, Vt.; Bucu, Va.; Iaeger, Va.-W. Va.; Winona, W. Va.

Progress in the drafting of additional sheets was made as follows: Hornell, N. Y., 20 per cent; Malone, N. Y., 50 per cent; Hurley, Va.-Ky., 67 per cent; Berryville, W. Va.-Va., 26 per cent; Capon Bridge, W. Va.-Va., 15 per cent; Gerrardstown, W. Va.-Va., 72 per cent; Martinsburg, W. Va.-Va.-Md., 91 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Center Star (Ala.), Talking Rock (Ga.), Blanchard (La.), Belfast, Liberty, and Portland (Me.), Vicksburg (Miss.), Canaseraga, Edwards, Hornell, and Oswegatchie (N. Y.), Belhaven, Bunyon, and Chocowinity (N. C.), Stahlstown, and Windgap (Pa.), Murfreesboro (Tenn.), Franklin Pond and St. Albans (Vt.), Bucu, Hurley, Iaeger, and Richlands (Va.) quadrangles.

Geographic positions were computed for the Weogufka (Ala.), Blanchard and Bossier (La.), Washington (D. C.-Md.), Natchez and Vicksburg (Miss.), Berne, Edwards, Malone, Moira, Oneonta, Oswegatchie, Sidney, and Stark (N. Y.), Belhaven, Bunyon, and Plymouth (N. C.), Berryville, Gerrardstown, and Martinsburg (W. Va.) quadrangles.

CENTRAL DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. The work comprised the completion of the survey of 25 quadrangles and of the resurvey of 7 quadrangles, in addition to which 19 quadrangles were partly surveyed and 3 were partly resurveyed. The total new area mapped was 5,208 square miles, for publication on the scale of 1 : 62,500; and the area resurveyed was 935 square miles, for publication on the scale of 1 : 62,500. In connection with this work 1,971 miles of primary levels were run and 454 permanent bench marks were established.

Primary traverse was carried on at different times by six parties, the work being distributed over portions of Illinois, Iowa, Kentucky, Michigan, Minnesota, and Wisconsin. The total area covered by the primary control was about 4,000 square miles, of which 3,600 square miles was controlled by primary traverse, 958 linear miles of primary traverse being run and 84 permanent marks set. Five triangulation stations were occupied and 4 marked. The result of this work was to make control available in 50 quadrangles.

Topographic surveys in central division from July 1, 1914, to June 30, 1915.

State.	Contour interval.	For publication on scale of 1 : 62,500.		Total area surveyed.	Primary levels.		Primary traverse.		Triangulation.	
		New.	Resurvey.		Distance run.	Bench marks.	Distance run.	Permanent marks.	Stations occupied.	Stations marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Illinois	20	539	....	539	461	135	373	31	....	....
Indiana	20	191	....	191	61	13	....	....	....	....
Iowa	20	119	....	119	....	....	82	13	....	....
Kentucky	50	....	913	913	168	47	89	6	5	4
Michigan	5, 20	273	....	273	....	....	151	14	....	....
Minnesota	10	454	....	454	11	2	12	1	....	....
Missouri	20	544	22	566	300	86	....	....	....	....
Ohio	10, 20	2,818	....	2,818	796	129	....	....	....	....
Wisconsin	20	270	....	270	174	42	251	19	....	....
		5,208	935	6,143	1,971	454	958	84	5	4

Illinois.—The governor of Illinois allotted $9,000 for the continuation of cooperative topographic surveys in Illinois and the United States Geological Survey allotted an equal amount. The survey of the Coulterville and Equality quadrangles and of the Illinois portions of the Shawneetown, Birds, Fords Ferry, and Golconda quadrangles in Perry, Randolph, St. Clair, Washington, Gallatin, Hardin, Pope, Saline, Crawford, and Lawrence counties was completed, and that of the Brownfield quadrangle, in Johnson, Massac, and Pope counties, was begun by C. W. Goodlove, Fred Graff, jr., Gilbert Young, J. A. Duck, R. G. Clinite, R. M. Herrington, and W. S. Gehres, the total area mapped being 539 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of the Brownfield, Morris, Birds, Good Hope, Paducah, Woodhull, Quincy, Orion, Alexis, Augusta, Monmouth, Meredosia, La Harpe, Mount Sterling, Camp Point, Griggsville, Pittsfield, and Barry quadrangles, in Johnson, Massac, Pope, Grundy, Kendall, Crawford, Lawrence, McDonough, Warren, Henry, Knox, Mercer, Adams, Pike, Rock Island, Brown, Schuyler, Hancock, Cass, Fulton, Henderson, Morgan, Scott, and Greene counties, S. R. Archer, E. C. Bibbee, G. W. Lucas, and R. G. Clinite ran 461 miles of primary levels and established 135 permanent bench marks. For the control of the Augusta, Beardstown, Good Hope, Lomax, Oquaka, Monmouth, Meredosia, La Harpe, Rushville, Kirkland, Wilmington, Sycamore, Shabbona, Quincy, Mount Sterling, Morris, Liberty, Earlville, Dwight, Camp Point, and Yorkville quadrangles, in Adams, Brown, Schuyler, Hancock, Cass, Fulton, McDonough, Warren, Henderson, Pike, Scott, Morgan, Ogle, Dekalb, Boone, Winnebago, Will, Kankakee, Kane, Lee, Grundy, Kendall, La Salle, and Livingston counties, E. L. McNair ran 373 miles of primary traverse and set 31 permanent marks.

Indiana.—The mapping of the Indiana portions of the Uniontown and Henderson quadrangles, in Posey and Vanderburg counties, was completed by C. W. Goodlove, W. S. Gehres, and R. M. Herrington, the area mapped being 148 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of these areas S. R. Archer and Marvin Lee ran 61 miles of primary levels and established 13 permanent bench marks. The survey of the Indiana portion of the Birds quadrangle, in Knox and Sullivan counties, was completed by Fred Graff, jr., the area mapped being 30 square miles, for publication on the same scale as the Illinois portion. The mapping of the Indiana portion of the Three Rivers quadrangle was completed by L. L. Lee and H. E. Burney, the area mapped being 13 square miles, for publication on the same scale as the Michigan portion.

Iowa.—The State geologist allotted $1,750 for the continuation of cooperative topographic surveys in Iowa and the Federal Survey allotted an equal amount. The survey of the Boone quadrangle, in Boone, Hamilton, and Webster counties, was completed, and that of the Chariton quadrangle, in Lucas, Marion, and Warren counties, was begun by W. L. Miller, the area mapped being 119 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of the Chariton quadrangle, and also of the Melrose, Attica, Humeston, New Virginia, and Albia quadrangles, in Lucas, Marion, Warren, Appanoose, Wayne, Clarke, Monroe, and Mahaska counties, E. L. McNair ran 82 miles of primary traverse and set 13 permanent marks.

Kentucky.—The Kentucky Geological Survey allotted $10,000 for the continuation of cooperative topographic surveys in Kentucky and the United States Geological Survey allotted an equal amount. The resurvey of the Laynesville and Inez quadrangles, in Floyd, Johnson, Lawrence, Martin, and Pike counties, and of the Kentucky portion of the Naugatuck, Hurley, Matewan, and Williamson quadrangles, in Lawrence, Pike, and Martin counties, was completed, and that of the Kentucky portion of the Regina quadrangle, in Pike County, was begun by J. R. Eakin, E. I. Ireland, C. P. McKinley, J. M. Rawls, Howard Clark, S. A. Judson, W. A. Reiter, F. W. Farnsworth, G. W. Lucas, W. S. Gehres, Klett McKinley, and Sylvan Price, the area mapped being 913 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 50 feet. For the control of the Laynesville, Hurley, Matewan, Naugatuck, Regina, and Williamson quadrangles S. R. Archer and Mr. Lucas ran 168 miles of primary levels and established 47 permanent bench marks. For the control of the Kuttawa quadrangle and of the Kentucky portions of the Fords Ferry, Golconda, and Smithland quadrangles, in Crittenden, Livingston, Marshall, Cracken, and Trigg counties, J. H. Wilson ran 89 miles of primary traverse and set 6 permanent marks, and for the control of the Paintsville and Goodloe quadrangles, in Breathitt, Magoffin, Johnson, Morgan, Lawrence, and Floyd counties, C. L. Nelson occupied 5 triangulation stations and marked 4.

Michigan.—For the continuation of cooperative topographic surveys in Michigan the State geologist allotted $2,500 and the United States Geological Survey allotted an equal amount. The survey of the St. Charles quadrangle and of the Michigan portion of the Three Rivers quadrangle, in Midland, Saginaw, and St. Joseph counties, was completed by C. L. Sadler, L. L. Lee, and H. E. Burney, the area mapped being 273 square miles, for publication on the scale of 1:62,500, with contour intervals of 5 and 20 feet. For the control of the Perrington, Elsie, Chesaning, and Saginaw quadrangles, in Bay, Clinton, Gratiot, Saginaw, and Shiawassee counties, J. H. Wilson ran 151 miles of primary traverse and set 14 permanent marks.

Minnesota.—The State drainage engineer of Minnesota allotted $4,500 for the continuation of cooperative topographic surveys in that State and the United States Geological Survey allotted an equal amount. The survey of the Aitkin, Pelican Rapids, and Wealthwood quadrangles, in Aitkin, Becker, Clay, and Ottertail counties, was completed, and that of the Brainerd quadrangle, in Crow Wing County, was begun by F. B. Barrett, J. H. Wilson, E. L. Hain, and L. B. Roberts, the area mapped being 454 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 10 feet. (See also Wisconsin, p. 119.)

Missouri.—For the continuation of cooperative topographic surveys in Missouri the State geologist allotted $5,221.74 and the United States Geological Survey allotted an equal amount. The survey of the Neosho and Eminence quadrangles, in McDonald, Newton, and Shannon counties, was completed by C. G. Anderson, R. L. Harrison, F. W. Hughes, J. M. Rawls, G. W. Lucas, R. H. Randall, W. F. Hicks, and R. M. Herrington, the area mapped being 477 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas and of the Bandyville, Low Wossie, Upalika, Puxico, Grandin, Greenbrier, Hendrickson, Advance, Cape Girardeau, and Morley quadrangles, in Oregon, Shannon, Carter, Ripley, Butler, Wayne, Stoddard, Bollinger, Cape Girardeau, and Scott counties, G. W. Lucas and E. C. Bibbee ran 300 miles of primary levels and established 86 permanent bench marks. The resurvey of the Sturgeon quadrangle, in Audrain, Boone, Howard, and Randolph counties, was completed by C. G. Anderson and W. L. Miller, the area mapped being 22 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet.

In addition to the cooperative work, the mapping of the Missouri portion of the Kimmswick quadrangle, in Jefferson and St. Louis counties, was completed by F. W. Hughes, R. H. Randall, and W. F. Hicks, the area mapped being 67 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet.

Ohio.—For the continuation of cooperative topographic surveys in Ohio the governor allotted $35,000 and the United States Geological Survey allotted $10,000. The survey of the Mechanicsburg, Greenfield, Milford Center, Octa, Xenia, Sabina, Morrow, Hillsboro, Sardinia, and Batavia quadrangles and of the Ohio portions of the Lawrenceburg, Richmond, Harrison, Lynn, and Portland quadrangles, in Adams, Brown, Butler, Champaign, Clark, Darke, Highland, Hamilton, Preble, Logan, Madison, Mercer, Union, Fayette, Ross, Clinton, Greene, Warren, and Clermont counties, was completed, and that of the West Union, Piketon, and Bainbridge quadrangles and of the Ohio portions of the Georgetown and Liberty quadrangles, in Adams, Brown, Butler, Preble, Highland, Pike, and Ross counties was begun, the total area mapped being 2,818 square miles for publication on the scale of 1 : 62,500, with contour intervals of 10 and 20 feet. This work was done by J. H. Jennings, A. B. Searle, Gilbert Young, Fred Graff, jr., R. L. Harrison, E. L. Hain, J. A. Duck, J. H. Wilson, F. B. Barrett, M. A. Roudabush, S. L. Parker,

E. C. Burt, R. M. Wilcoxon, Howard Clark, W. A. Reiter, H. E. Burney, W. S. Gehres, and S. A. Judson. For the control of these areas and of the Piketon and Roxabell quadrangles and the Ohio portions of the Bethel, Maysville, Morningview, and Liberty quadrangles, in Pike, Butler, Ross, Brown, Preble, Hamilton and Clermont counties, F. L. Whaley, J. M. Perkins, Mr. Parker, S. R. Archer, and E. C. Bibbee ran 796 miles of permanent levels and established 129 permanent bench marks.

Wisconsin.—For the beginning of cooperative topographic surveys in Wisconsin the State geologist allotted $4,000 and the United States Geological Survey allotted an equal amount. The survey of the Neshkoro and Ripon quadrangles, in Fond du Lac, Green Lake, Marquette, Winnebago, and Waushara counties and of the Wisconsin portion of the Old Superior quadrangle, in Douglas County, was begun by L. L. Lee, L. B. Roberts, and R. M. Herrington, the area mapped being 198 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of these areas E. C. Bibbee and J. M. Perkins ran 173 miles of primary levels and established 44 permanent bench marks, of which 11 miles and 2 marks were in Minnesota. For the control of these areas and of the Fisk, Chaffey, Ripon, Rockmont, Oshkosh, Carlton, Poy Sippi, Montello, Spring Lake, Portage, Cambria, and Fox Lake quadrangles in Fond du Lac, Portage, Columbia, Dodge, Winnebago Douglas, Green Lake, Marquette, Waushara, Outagamie, and Waupaca counties, Wis., and Carlton and St. Louis counties, Minn., E. L. McNair ran 263 miles of primary traverse and set 20 permanent marks, of which 12 miles and 1 mark were in Minnesota.

In addition to the cooperative work the survey of the Wilton quadrangle in Monroe County was completed by R. T. Evans, O. H. Nelson, D. H. Watson, and J. M. Perkins, the area mapped being 72 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of this area Mr. Perkins ran 12 miles of primary levels.

OFFICE WORK.

The drafting of the following sheets was completed: Birds, Ill.-Ind.; Coulterville and Equality, Ill.; Shawneetown, Ill.-Ky.; Henderson and Uniontown, Ind.-Ky.; Boone, Iowa; Inez, Laynesville, and Virgie, Ky.; St. Charles, Mich.; Three Rivers, Mich.-Ind.; Aitkin, Pelican Rapids, and Wealthwood, Minn.; Kimmswick, Mo.-Ill.: Neosho and Sturgeon, Mo.; Batavia, Greenfield, Mechanicsburg, Milford Center, Morrow, Octa, Sabina, St. Paris, and Xenia, Ohio; Wilton, Wis.

Progress in the drafting of additional sheets was made as follows: Brownfield, Ill.-Ky., 10 per cent; Fords Ferry, Ill.-Ky., 9 per cent; Golconda, Ill.-Ky., 32 per cent; Chariton, Iowa, 25 per cent;

Brainerd, Minn., 30 per cent; Eminence, Mo., 70 per cent; Hillsboro, Ohio, 70 per cent; Sardinia, Ohio, 55 per cent; Old Superior, Wis.-Minn., 35 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Birds, Brownfield, Camp Point, Equality, Good Hope, La Harpe, Lomax, Meredosia, Morris, Paducah, Pittsfield, Quincy, Shawneetown, and Sparta (Ill.), Alzey and Evansville (Ind.), Hurley, Inez, Laynesville, and Matewan (Ky.), Advance, Eminence, Neosho, Salem, and Sinkin (Mo.), Bainbridge, Batavia, Bethel, Hillsboro, Lawrenceburg, Morrow, Piketon, Portland, Richmond, Roxabell, and Sabina (Ohio), Old Superior and Wilton (Wis.) quadrangles.

Geographic positions were computed for the Augusta, Beardstown, Camp Point, Good Hope, La Harpe, Liberty, Lomax, Meredosia, Monmouth, Morris, Mount Sterling, Oquawka, Quincy, Rushville, and Shabbona (Ill.), Attica and Chariton (Iowa), Chesaning, Elsie, and Perrinton (Mich.), Eminence, Knobnoster, Neosho, Odessa, and Warrensburg (Mo.), Cambria, Fisk, Fox Lake, Montello, Neshkoro, Old Superior, Oshkosh, Portage, Poy Sippi, Ripon, and Spring Lake (Wis.) quadrangles.

ROCKY MOUNTAIN DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Colorado, Montana, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming, and in a small area in Minnesota. This work comprised the completion of the survey of 10 quadrangles and 1 special area and the resurvey of 2 quadrangles and 1 special area, in addition to which 10 quadrangles and 2 special areas were partly surveyed and 1 special area was partly resurveyed. The total new area mapped was 3,855 square miles, 3,247 square miles for publication on the scale of 1 : 125,000, 429 square miles for publication on the scale of 1 : 62,500, 149 square miles for publication on scale of 1: 31,680, and 30 square miles for publication on the scale of 1: 12,000. The total area resurveyed was 526 square miles, 484 square miles for publication on the scale of 1 :62,500, and 42 square miles for publication on the scale of 1 :24,000. In addition the map of 1 quadrangle was revised and that of 1 quadrangle was partly revised, the area covered being 1,215 square miles. In connection with this work 2,179 miles of primary levels were run and 592 permanent bench marks were established.

Primary traverse and primary triangulation were carried on at different times by 7 parties, the work extending over portions of Colorado, New Mexico, Oklahoma, Texas, and Wyoming. The total area covered by this primary control was about 15,400 square miles, of which 1,440 square miles was controlled by primary traverse, 662 miles being run and 196 permanent marks set. Ninety triangulation stations were occupied and 56 marked. This work made control available in 60 quadrangles.

Topographic surveys in Rocky Mountain division from July 1, 1914, to June 30, 1915.

State.	Contour interval.	For publication on scale of—					
		1: 125,000.	1:62,500.		1:31,680.	1:24,000.	1:12,000.
		New.	New.	Re-survey.	New.	Re-survey.	New.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*
Colorado	5, 100	1,338			101		
Montana	20, 100	389	50				
New Mexico	25, 50, 100	1, 238				42	
Oklahoma	25		83	484			
Texas	2, 5, 25		21		48		30
Wyoming	25, 50	282	275				
		3, 247	429	484	149	42	30

State.	Total area surveyed.	Primary levels.		Primary traverse.		Triangulation.	
		Distance run.	Bench marks.	Distance run.	Permanent marks.	Stations occupied.	Stations marked.
	Sq. mi.	*Miles.*		*Miles.*			
Colorado	1, 439	552	152			58	35
Montana	439						
Nebraska		13	2				
New Mexico	1, 280	689	180			10	8
Oklahoma	567	160	48	94	13		
South Dakota		3	2				
Texas	99	588	175	568	183	18	12
Wyoming	557	142	25			1	
Arizona		23	6				
Minnesota		9	2				
	4, 381	2, 179	592	662	196	87	55

Arizona.—(See New Mexico, p. 123.)

Colorado.—The mapping of the Craig quadrangle, in Moffat County, and the San Luis Lake special area, in Alamosa County, was completed, and that of the Naturita quadrangle, in Montrose and San Miguel counties, was begun by C. L. Nelson, C. W. Rowell, J. H. Wilke, C. T. Moore, R. W. Berry, E. P. Davis, Basil Duke, and R. R. Monbeck, the area mapped being 736 square miles, 635 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet, and 101 square miles for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of these areas and of the Coventry and Montrose quadrangles, in Montrose, San Miguel, Ouray, Gunnison, and Hinsdale counties, J. R. Ellis, Mr. Monbeck, R. W. Burchard, Mr. Rowell, and Mr. Moore ran 487 miles of primary levels and established 131 permanent bench marks, and for the control of the Naturita quadrangle C. F. Urquhart occupied

8 triangulation stations and permanently marked 9. The survey of the Creede quadrangle, lying partly in the San Juan, Cochetopa, and Rio Grande national forests, in Mineral, Rio Grande, and Saguache counties, was completed, and that of the Del Norte and Home quadrangles, lying partly in the Rio Grande, Cochetopa, Arapahoe, and Colorado national forests, in Alamosa, Jackson, Larimer, Rio Grande, and Saguache counties, was begun by Mr. Duke, C. A. Ecklund, R. C. Seitz, Cornelius Schnurr, and C. C. Holder, the area mapped being 703 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 324 square miles is in the national forests. For the control of the Home quadrangle Mr. Ecklund and Roscoe Reeves ran 65 miles of primary levels and established 21 permanent bench marks. For the control of the Del Norte, Glenwood Springs, Kremmling, Home, Pagoda, Rabbit Ears Peak, Eagle, Leadville, Leon Peak, Mount Powell, Snow Mass Mountain, Gateway, Delta, Livermore, Grand Junction, Pinon Valley, Cameo, and De Beque quadrangles, Colorado, and the Sherman quadrangle, Wyoming, lying partly in the Leadville, Holy Cross, Sopris, Arapahoe, Colorado, Routt, White River, Gunnison, and Battlement national forests, in Eagle, Garfield, Rio Blanco, Routt, Grande, Jackson, Delta, Mesa, Moffat, Lake, Peak, Larimer, Summit, Chaffee, Pitkin, and Gunnison counties, Colo., and Albany and Laramie counties, Wyo., C. F. Urquhart, C. B. Kendall, and Mr. Ellis occupied 51 triangulation stations (1 in Wyoming) and marked 26.

The roads in the Mesa Verde National Park were located on the administrative map of the park by C. L. Nelson for the Department of the Interior, all the expenses of the work being borne by the Department.

Minnesota.—(See South Dakota, North Dakota, and Minnesota, p. 124.)

Montana.—The survey of the unmapped portion of the Nashua quadrangle, in Dawson and Valley counties, was completed, and that of the unmapped portion of the Nameless quadrangle, in Valley County, was begun by R. C. Seitz, the area mapped being 50 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The portions of these quadrangles lying in the Fort Peck Indian Reservation were mapped by the General Land Office. The survey of the unmapped portion of the Heart Butte quadrangle, lying partly in the Lewis and Clark National Forest, in Flathead and Teton counties, was completed by R. T. Evans, O. H. Nelson, and D. H. Watson, the area mapped being 389 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 100 feet, 153 square miles being in the national forest. The remainder of this quadrangle, lying in the Blackfeet Indian Reservation, was mapped by the General Land Office. (See also Idaho-Montana, p. 127.)

Nebraska.—For the control of the Stella and Falls City quadrangles in Richardson County, S. H. Birdseye ran 13 miles of primary levels and established 2 permanent bench marks.

New Mexico.—The mapping of the Tularosa and Tres Hermanos quadrangles, in Dona Ana, Otero, Socorro, and Lincoln counties, was completed, and that of the Reserve quadrangle, lying partly in the Socorro National Forest, in Socorro County, was begun by R. C. Seitz, C. C. Gardner, S. T. Penick, C. C. Holder, and D. H. Watson, the total area mapped being 1,238 square miles, for publication on the scale of 1:125,000, with contour intervals of 50 and 100 feet. Of this area 462 square miles was in the national forest. For the control of these areas and of the Koehler, Soudders, Magdalena, Leura Springs, Datil, Mogollon, and Nutrioso quadrangles, in Sierra, Colfax, and Socorro counties, N. Mex., and Apache and Greenlee counties, Ariz., Mr. Holder and R. W. Burchard ran 712 miles of primary levels and established 186 permanent bench marks, of which 23 miles and 6 marks were in Arizona. For the control of the Koehler quadrangle Mr. Ellis occupied 10 triangulation stations and permanently marked 8. The resurvey of the Tyrone special area, in Grant County, was completed, and that of the Mogollon special area, in Socorro County, was begun by B. A. Jenkins and R. W. Berry, the area mapped being 42 square miles, for publication on the scale of 1:24,000, with a contour interval of 25 feet. The map of the Deming quadrangle, in Luna County, was revised by E. P. Davis, the area covered by this revision being 1,009 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. (See also Arizona, p. 131.)

North Dakota.—(See South Dakota, North Dakota, and Minnesota, p. 124.)

Oklahoma.—The director of the Oklahoma Geological Survey allotted $1,000 for the continuation of cooperative topographic surveys in that State and the United States Geological Survey allotted an equal amount. The survey of the Foraker quadrangle, in Osage County, was completed by S. T. Penick and R. R. Monbeck, the area mapped being 83 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. The resurvey of the Kiefer and Bristow quadrangles, in Creek, Tulsa, and Okmulgee counties, was completed by R. T. Evans, Mr. Penick, C. C. Gardner, R. H. Reineck, Mr. Monbeck, A. O. Burkland, D. H. Watson, and C. R. Fisher, the area mapped being 484 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. For the control of these areas Mr. Fisher and Mr. Monbeck ran 160 miles of primary levels and established 48 permanent bench marks, and C. B. Kendall and Mr. Fisher ran 94 miles of primary traverse and set 13 permanent marks. The cooperative funds being insufficient to cover the completion of the mapping of these areas, the additional expenses were borne by the Federal Survey.

In addition to the cooperative work the revision of the map of the Hominy quadrangle, in Osage, Pawnee, Tulsa, and Creek counties, was completed by R. W. Berry, the total area covered by this revision being 206 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 50 feet.

South Dakota, North Dakota, and Minnesota.—For the control of the White Rock quadrangle, in Roberts County, S. Dak., Richland County, N. Dak., and Traverse County, Minn., A. J. Kavanagh ran 12 miles of primary levels and established 4 permanent bench marks, of which 9 miles and 2 marks were in Minnesota and 3 miles and 2 marks in South Dakota.

Texas.—For the cooperative topographic survey of Harris County the county allotted $35,000 and the United States Geological Survey allotted $5,000. The mapping of the Erin, Deepwater, and Rice 7½-minute quadrangles was begun by C. H. Birdseye, B. A. Jenkins, W. B. Lewis, E. R. Bartlett, O. H. Nelson, J. H. Wilke, T. P. Pendleton, and F. A. Danforth, the area mapped being 48 square miles, for publication on the scale of 1 : 31,680, with a contour interval of 5 feet. For the control of these quadrangles and of the Settegast, Vollner, Hillendahl, Missouri City, Pearland, Strang, Almeda, Clodine, Barker, Katy, Swanson, Cypress, Ashford, Hockley, Rose Hill, Waller, Number Two, Louetta, Spring, Humble, Aldine, Kliber, Pauli, Huffman, Crosby, Hermaston, Fauna, and Stuebner quadrangles, E. L. McNair and W. F. Hicks ran 470 miles of primary traverse and set 147 permanent marks, and R. R. Monbeck ran 281 miles of primary levels and established 89 permanent bench marks.

In addition to the cooperative work, the mapping of the Henrietta quadrangle, in Clay, Archer, and Wichita counties, was begun by C. A. Ecklund and A. O. Burkland, the total area mapped being 21 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. For the control of this area and of the Walter quadrangle, in Clay and Wichita counties, Roscoe Reeves ran 141 miles of primary levels and established 38 permanent bench marks, and for the control of these areas and of the Archer City and Eschite quadrangles, in Archer, Wichita, and Wilbarger counties, J. R. Ellis and Mr. Ecklund occupied 18 triangulation stations and marked 12. The mapping of the Sabine and Trinity River projects, in Wood, Smith, Dallas, Ellis, and Kaufman counties was commenced by C. H. Birdseye, B. A. Jenkins, W. B. Lewis, E. R. Bartlett, and R. R. Monbeck, the area mapped being 30 square miles, for publication on the scale of 1 : 12,000, with a contour interval of 2 feet. For the control of these areas E. L. McNair, Mr. Birdseye, and Mr. Monbeck ran 166 miles of primary levels and established 48 permanent bench marks, and Mr. McNair ran 98 miles of primary traverse and set 36 permanent marks.

Wyoming.—The mapping of the Blue Mesa and Saddleback Hills quadrangles, in Carbon, Hot Springs, and Washakie counties, was completed by R. H. Reineck, C. C. Gardner, S. T. Penick, and C. R. Fisher, the total area mapped being 275 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. The mapping of the Moorcroft quadrangle, in Crook and Weston counties, was begun by Messrs. Gardner, Reineck, and Fisher, the area mapped being 282 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of these areas Mr. Fisher and G. R. Ruby ran 142 miles of primary levels and established 25 permanent marks.

OFFICE WORK.

The drafting of the following sheets was completed: Craig, Creede, and San Luis Lake, Colo.; Heart Butte and Nashua, Mont.; Deming (revision), N. Mex.; Tres Hermanos, Tularosa, and Tyrone special, N. Mex.; Bristow, Foraker, and Kiefer, Okla.; Claremore and Hominy (revision), Okla.; Mission, Sabine River, San Juan, and Trinity River, Tex.; Blue Mesa and Saddleback Hills, Wyo.

Progress in the drafting of additional sheets was made as follows: Del Norte, Colo., 18 per cent; Home, Colo., 7 per cent; Naturita, Colo., 22 per cent; Nameless, Mont., 83 per cent; Moorcroft, Wyo., 8 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Nutrioso (Ariz.-N. Mex.), Coventry, Del Norte, Home, Hooper, La Jara, Lay, Montrose, Naturita, Saguache, and Silesia (Colo.), Dodson and Hays (Mont.), Datil, Tres Hermanos, Koehler, Luera Springs, Magdalena, Ojo Caliente, Patterson, Reserve, Shiprock, Soudders, Pineville, and Tularosa (N. Mex.), Blue Butte and Elbowoods (N. Dak.), Nuyaka (Okla.), Archer City, Eschite, Henrietta, Walter, Almeda, Deepwater, Erin, Missouri City, Pearland, Rice and Strang, and the Wills Point and Mineola (Sabine River project) and Dallas and Kaufman (Trinity River project) (Tex.), Thermopolis and Widdowfield (Wyo.) quadrangles.

Geographic positions were computed for the Del Norte, Grand Junction, Eagle, Glenwood Springs, Kremmling, Leadville, Leon Peak, Naturita, Meeker, Mount Jackson, Mount Powell, Pagoda, Rabbit Ears Peak, DeBeque, Delta, Gateway, Palisades, Rifle, and Snow Mass Mountain (Colo.), Koehler (N. Mex.), Bristow and Kiefer (Okla.), Almeda, Archer City, Eschite, Henrietta, Bonham, Dallas (Trinity River project), Wills Point (Sabine River project), Almeda, Deepwater, Erin, Missouri City, Paris, Pearland, Petrolia, Rice,

Strang, Webster, Barker, Clodine, Cypress, Hillendahl, Katy, Missouri City, Swanson, Vollner, Aldine, Ashford, Hockley, Louetta, Rose Hill, Spring, and Waller (Harris County) (Tex.) quadrangles.

NORTHWESTERN DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Idaho, Oregon, and Washington and in a small area in Montana. This work comprised the completion of the survey of 10 quadrangles and the partial survey of 10 quadrangles. The total new area mapped was 4,008 square miles; 2,974 square miles for publication on the scale of 1 : 125,000; 870 square miles for publication on the scale of 1 : 62,500; and 164 square miles for publication on the scale of 1:31,680. In connection with this work 747 miles of primary levels were run and 202 permanent bench marks were established. In addition, profile surveys were made of portions of 5 rivers, the distance traversed being 262 linear miles for publication on the scale of 1 : 31,680.

Primary triangulation and primary traverse were carried on at different times by five parties in portions of Idaho, Montana, Oregon, and Washington. The total area covered by this primary control was about 7,200 square miles, of which about 575 square miles was controlled by primary traverse, 149 miles being run and 40 permanent marks set. Sixty-five triangulation stations were occupied and 58 permanently marked. This work made control available in 23 quadrangles.

Topographic surveys in northwestern division from July 1, 1914, to June 30, 1915.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Primary levels.		Primary traverse.		Triangulation.	
		1:125,000	1 : 62,500	1 : 31,680		Distance run.	Bench marks.	Distance run.	Permanent marks.	Stations occupied.	Stations marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq.mi.*	*Miles.*		*Miles.*			
Idaho.......	50, 100	334	351	2	687	178	35	....	....	62	58
Oregon......	5, 25, 50, 100	1,305	304	162	1,771	357	112	79	20	....	....
Washington	25, 50	1,217	215	....	1,432	212	55	70	20	....	....
Montana....	100	118	....	....	118	....	....	....	....	3	....
		2,974	870	164	4,008	747	202	149	40	65	58

Idaho.—The mapping of the Henry and Portneuf quadrangles, in Bannock County, was completed, and that of the Mink Creek quadrangle, lying partly in the Cache National Forest, in Bannock, Bear Lake, and Franklin counties, was begun by Albert Pike, J. L. Lewis, and C. G. Anderson, the area mapped being 563 square miles, 351 square miles for publication on the scale of 1:62,500, with a contour interval of 50 feet, and 212 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 80 square miles was in the national forest. For the control of these areas and of the Soda Springs quadrangle, in Bannock and Bear Lake counties, F. L. Whaley ran 178 miles of primary levels and established 35 permanent bench marks. For the control of these areas, and of the Malad City and Sterrett quadrangles, and the south half of the Ammon quadrangle, in Bannock, Bingham, and Oneida counties, H. H. Hodgeson and T. M. Bannon occupied 22 and marked 21 triangulation stations. A profile survey of Snake River was commenced by C. G. Anderson, the distance traversed being 48 linear miles in Madison County. In connection with this work 2 square miles covering a power site were surveyed.

Idaho-Montana.—The mapping of the Avery quadrangle, lying partly in the Lolo, Cabinet, St. Joe, and Cœur d'Alene national forests, in Shoshone County, Idaho, and Mineral and Sanders counties, Mont., was completed, and that of the St. Regis quadrangle, lying partly in the St. Joe, Lolo, and Cabinet national forests, in the same counties, was begun by J. E. Blackburn, the total area mapped being 240 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 178 square miles is in the national forests and 118 square miles in Montana. In connection with the mapping of the Avery quadrangle 5 square miles of the map of the Cœur d'Alene National Forest was revised. For the control of the Salmon, Noble, Gibbons Pass, Vinegar Hill, Casto, Rabbit Foot, May, Custer, Bay Horse, Mackay, and Hailey quadrangles, lying partly in the Bitterroot, Selway, Beaverhead, Salmon, Lemhi, Idaho, Sawtooth, Nez Perce, and Challis national forests, in Lemhi and Custer counties, Idaho, and Ravalli and Beaverhead counties, Mont., T. M. Bannon occupied 43 triangulation stations (3 in Montana) and marked 37.

Oregon.—For the continuation of cooperative topographic surveys in Oregon the State engineer allotted $18,000 and the United States Geological Survey allotted an equal amount. In the survey of the Willamette Valley the mapping of the Salem, Corvallis, Lebanon, and Brownsville quadrangles, in Benton, Marion, Linn, and Polk counties, was continued, and that of the Dallas quadrangle, in Polk County, was begun by Charles Hartmann, Olinus Smith, J. H. Le Feaver, R. B. Kilgore, and D. S. Birkett, the total area mapped being 162 square miles for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of these areas Mr. Birkett and E. M. Bandli ran 82 miles of primary levels and established 27 permanent bench marks. The mapping of the Tualatin and Condon quadrangles, in Clackamas, Washington, Jefferson, Yamhill, Gilliam, Morrow, Sherman, and Wheeler counties, was completed, and that of the Hillsboro quadrangle, in Columbia, Multnomah, and Washington counties, was begun by C. H. Birdseye, Albert Pike, C. L. Sadler, Fred Graff, jr., S. G. Lundey, O. H. Nelson, and J. H. Le Feaver, the total area mapped being 959 square miles, 655 square miles for publication on the scale of 1:125,000, with a contour interval of 50 feet, and 304 square miles for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the Condon and Hillsboro quadrangles and also of the Twickenham and Heisler quadrangles, in Crook, Jefferson, Wheeler, and Wasco counties, E. M. Bandli ran 134 miles of primary levels and established 45 permanent bench marks, and for the control of the Hillsboro quadrangle L. F. Biggs ran 79 miles of primary traverse and set 20 permanent marks. Profile surveys of portions of Willamette, Umpqua, and White rivers were made by Albert Pike and C. P. McKinley, the distance traversed being 172 linear miles in Douglas, Lane, and Wasco counties. Of this distance 60 miles lies in the Cascade and Umpqua national forests.

In addition to the cooperative work in Oregon, the mapping of the Diamond Lake quadrangle in the Crater, Cascade, Paulina, and Umpqua national forests, in Douglas, Klamath, Jackson, and Lane counties, was completed, and that of the Kerby quadrangle, lying partly in the Siskiyou National Forest, in Curry and Josephine counties, was begun by J. G. Staack, A. O. Burkland, R. B. Kilgore, R. M. Wilson, and John McCombs, the total area mapped being 650 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 600 square miles is in the national forests. For the control of this area and of the Diamond Peak, Disston, Wendling, and Eugene quadrangles, lying partly in the Cascade, Paulina, Santiam, and Umpqua national forests, in Douglas, Lane, Klamath, and Linn counties, R. M. Wilson ran 141 miles of primary levels and established 40 permanent bench marks. A profile survey of the portion of North Umpqua River in the Diamond Lake quadrangle was made by Mr. Kilgore, the distance traversed being 42 linear miles, for publication on the scale of 1:48,000, with contour intervals of 5 and 25 feet.

Washington.—For the continuation of cooperative topographic surveys in Washington the State Board of Geological Survey allotted $11,500 and the United States Geological Survey allotted an equal amount. The mapping of the Coyote Rapids, Priest Rapids, and Pasco quadrangles, in Benton, Grant, Kittitas, Yakima, Franklin, and Walla Walla counties, was completed by H. L. McDonald and S. G. Lunde, the total area mapped being 816 square miles, 215 square miles for publication on the scale of 1 : 62,500, with a contour interval of 25 feet, and 601 square miles for publication on the scale of 1 : 125,000, with a contour interval of 50 feet. The mapping of the Chehalis quadrangle, lying partly in the Rainier National Forest, in Lewis, Pierce, and Thurston counties, was completed, and that of the Prosser quadrangle, in Benton, Klickitat, and Yakima counties, was begun by W. O. Tufts, H. L. McDonald, N. E. Ballmer, L. V. Fees, John McCombs, and A. L. Wilson, the area mapped being 616 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 50 feet. Of this area 1½ square miles is in the national forest. For the control of the Chehalis quadrangle L. F. Biggs ran 7 miles of primary traverse and set 3 permanent marks. For the control of the Prosser quadrangle and also of the Wallula quadrangle, in Benton, Franklin, and Walla Walla counties, D. S. Birkett ran 123 miles of primary levels and established 36 permanent bench marks.

In addition to the cooperative work, for the control of the Mount St. Helens and Eatonville quadrangles, lying partly in the Columbia and Rainier national forests, in Clarke, Cowlitz, Lewis, Pierce, Skamania, and Thurston counties, Mr. Biggs and C. P. McKinley ran 63 miles of primary traverse and set 17 permanent marks, and for the control of the Mount St. Helens quadrangle and also of the Kalama quadrangle, in Cowlitz County, Mr. Biggs ran 89 miles of primary levels and established 19 permanent bench marks.

OFFICE WORK.

The drafting of the following sheets was completed: Henry and Portneuf, Idaho; Avery, Idaho-Mont.; Condon, Diamond Lake, North Umpqua River, Tualatin, Umpqua River, White River, and Willamette River, Oreg.; Chehalis, Coyote Rapids, Pasco, and Priest Rapids, Wash.

Progress in the drafting of additional sheets was made as follows: St. Regis, Idaho-Mont., 33 per cent; Brownsville, Oreg., 15 per cent; Corvallis, Oreg., 30 per cent; Dallas, Oreg., 17 per cent; Lebanon, Oreg., 37 per cent; Salem, Oreg., 45 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Bruneau, Portneuf, Henry, Lanes Creek, Mink Creek, Mountain Home, Riddle, and Tindall (Idaho); Brownsville, Condon, Corvallis, Diamond Lake, Diamond Peak, Disston, Heisler, Hillsboro, Lebanon, and Twickenham (Oreg.); Kalama, Mount St. Helens, and St. Helens (Wash.) quadrangles.

Geographic positions were computed for the Bay Horse, Casto, Custer, Dickey, May, Nicholia, Noble, Rabbit Foot, and Vinegar Hill (Idaho); Junction, Polaris, Noble, and Salmon (Idaho-Mont.); Hillsboro (Oreg.); and Kalama and Mount St. Helens (Wash.) quadrangles.

PACIFIC DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Arizona, California, Nevada, and Utah. This work comprised the completion of the survey of 19 quadrangles and the resurvey of 4 quadrangles and 1 special area, in addition to which 4 quadrangles were partly surveyed. The map of a partial quadrangle was revised to bring it up to date with the new work, the area covered by this revision being 210 square miles. The total new area mapped was 5,161 square miles, 3,641 square miles for publication on the scale of 1 : 125,000, 995 square miles for publication on the scale of 1 : 62, 500, and 525 square miles for publication on the scale of 1 : 31,680. The area resurveyed was 504 square miles, 167 square miles for publication on the scale of 1 : 125,000, 299 square miles for publication on the scale of 1 : 62,500, and 38 square miles for publication on the scale of 1 :24,000. In connection with this work 787 miles of primary and precise levels were run and 167 permanent bench marks were established. In addition, profile surveys were made of 7 rivers, the distance traversed being 236 linear miles.

Primary triangulation was carried on at different times by four parties, the work being distributed over portions of California and Nevada. The total area covered by this primary control was about 3,600 square miles, 71 triangulation stations being occupied and 37 marked. The result of this work was to make control available in 44 quadrangles.

Topographic surveys were made in the Territory of Hawaii, covering portions of one island (Hawaii). The survey of one 15-minute quadrangle was completed, the area mapped being 19 square miles, for publication on the scale of 1 : 31,680, with a contour interval of 10 feet.

Topographic surveys in Pacific division from July 1, 1914, to June 30, 1915.

State.	Contour interval.	For publication on scale of—						Total area surveyed.	Primary and precise levels.		Triangulation.	
		1:125,000		1:62,500		1:31,680	1:24,000					
		New	Re-survey.	New	Re-survey.	New	Re-survey.		Distance run.	Bench marks.	Stations occupied.	Stations marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*			
Arizona	25, 100	642	......	290	......	......	......	932	165	32	......	......
California	5, 25, 100	2, 362	......	705	69	525	......	3, 661	429	86	63	32
Nevada	5	53	......	......	......	......	38	84	150	39	8	5
Utah	50, 100	507	167	......	230	......	......	911	43	10	......	......
New Mexico	100	77	......	......	......	......	......	77	......	......	......	......
		3, 641	167	995	299	525	38	5, 665	787	167	71	37
Hawaii	10	......	......	......	......	19	......	......	......	......	......	......

Arizona.—The survey of the Gila Butte and Christmas quadrangles, in Maricopa, Gila, and Pinal counties, was completed by T. P. Pendleton and C. A. Stonesifer, the total area mapped being 290 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. In connection with the mapping of the Gila Butte quadrangle, the map of the area previously surveyed was revised, the total area covered by this revision being 210 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. For the control of the Christmas and Ray quadrangles, in Gila and Pinal counties, S. H. Birdseye ran 50 miles of primary levels and established 10 permanent bench marks. The mapping of the San Simon quadrangle, lying partly in the Chiricahua National Forest, in Cochise, Graham, and Greenlee counties, Ariz., and Grant County, N. Mex., was completed by F. A. Danforth and Cornelius Schnurr, the area mapped being 719 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 100 feet. Of this area 61 square miles is in the national forest and 77 square miles in New Mexico. For the control of this area and of the Duncan, Solomonsville, San Carlos, Bisbee, and Pearce quadrangles, lying partly in the Apache, Chiricahua, Crook, and Gila national forests, in Gila, Cochise, Graham, Greenlee, and Pinal counties, Ariz., and Grant County, N. Mex., Mr. Birdseye ran 115 miles of primary levels and established 22 permanent bench marks, all this work being in Arizona. (See also New Mexico, p. 123.)

California.—For the continuation of cooperative topographic surveys in California the department of engineering allotted $14,000 and the United States Geological Survey allotted an equal amount. In continuation of the survey of the San Joaquin Valley the mapping of the Denair, Cressy, Ceres, Crows Landing, Mitchell School, Winton, Merced, Hopeton, and Turlock 7½-minute quadrangles and of the Copperopolis 15-minute quadrangle, in Calaveras, Merced, Stanislaus, and Tuolumne counties, was completed by A. O. Burkland, H. W. Peabody, A. J. Ogle, J. B. Leavitt, S. H. Birdseye, F. A. Danforth, and C. A. Stonesifer, the total area mapped being 683 square miles, 525 square miles for publication on the scale of 1 : 31,680, with a contour interval of 5 feet, and 158 square miles for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. For the control of the Crows Landing, Mitchell School, Turlock, Stevinson, No. VII, No. VIII, No. IX, No. X, Deadman Creek, Kearney Peak, Le Grand, Jesbel, Clovis, Chowchilla Slough, Minturn, Berendo, Fresno, Friant, Herndon, Planada, Plainsberg, Sharon, Madera, Bridge, No. XV, No. XVI, No. XVII, No. XIX, No. XX, No. XXI, Merced, Newman, Ingomar, Owens Creek, Las Garzas Creek, San Luis Creek, Mariposa Slough, Salt Slough, Gustine, Volta, Los Banos, Elgin, Center School, and Daulton 7½-minute quadrangles and the Indian Gulch 15-minute quadrangle, in Madera, Fresno, Merced, Stanislaus, Mariposa, and San Joaquin counties, C. L. Nelson, C. F. Urquhart, and L. F. Biggs occupied 63 triangulation stations and marked 32, and for the control of the Copperopolis, Trigo, Bachelor Valley, No. VII, No. IX, No. X, Deadman Creek, Owens Creek, Indian Gulch, Le Grand, Madera, Berendo, Sharon, Planada, Plainsberg, La Grange, Daulton, Snelling, and Merced Falls quadrangles, in the same counties, Roscoe Reeves and D. S. Birkett ran 141 miles of primary levels and established 37 permanent bench marks.

In addition to the funds for regular cooperative surveys in California, $2,500 was allotted by the University of California for the survey of the Santa Rosa quadrangle, in Napa and Sonoma counties, and the United States Geological Survey allotted an equal amount. The funds from the university were made available in the spring of 1914, as stated in the previous report, when field work was commenced. During the year the survey of the Santa Rosa quadrangle was completed by J. P. Harrison, B. A. Jenkins, and A. J. Ogle, the area mapped being 159 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet.

The city of Los Angeles allotted $2,500 for the cooperative topographic survey of the Elizabeth Lake quadrangle, lying partly in the Santa Barbara National Forest, in Los Angeles and Kern counties, and the United States Geological Survey allotted an equal amount. The mapping of this quadrangle was completed by D. L. Reaburn, C. P. McKinley, N. E. Ballmer, Roscoe Reeves, and J. W. Muller, the total area mapped being 981 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 221 square miles is in the national forest. The services of Mr. Reaburn were provided by the city of Los Angeles, by which his salary and expenses were paid. In connection with the mapping of this quadrangle Mr. Ballmer mapped 44 square miles in the Kramer quadrangle, which lies directly east of the Elizabeth Lake area.

In addition to the cooperative work the survey of the Seiad and Sawyers Bar quadrangles, lying partly in the Klamath, Siskiyou, and Trinity national forests, in Humboldt, Siskiyou, and Trinity counties, was completed, and that of the Preston quadrangle, in the Klamath and Siskiyou national forests, in Del Norte and Siskiyou counties, was begun by J. P. Harrison, J. W. Muller, and W. R. Chenoweth, the area mapped being 744 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. This entire area is within the national forests. In connection with the mapping of these quadrangles profile surveys of portions of Klamath, Scott, and Salmon rivers were made by Messrs. Harrison, Muller, and Chenoweth, the distance traversed being 149 linear miles, for publication on the

the scale of 1:48,000, with contour intervals of 5 and 25 feet. For the control of the Preston quadrangle Mr. Biggs ran 72 miles of primary levels and established 20 permanent bench marks. The resurvey of the Mare Island quadrangle was completed by Mr. Leavitt, the area mapped being 69 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. The survey of the Pajaro and Morgan Hills quadrangles, in San Benito, Santa Clara, Santa Cruz, and Monterey counties, was begun, and that of the Cholame quadrangle, in Fresno, Kern, Kings, Monterey, and San Luis Obispo counties was continued by E. P. Davis, J. E. Blackburn, A. T. Fowler, H. W. Peabody, A. J. Ogle, Olinus Smith, J. H. Le Feaver, N. E. Ballmer, and J. B. Leavitt, the total area mapped being 742 square miles, 354 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet, and 388 square miles for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the Bridgeport, Mount Lyell, Mount Morrison, and Bishop quadrangles, in Mono, Fresno, and Inyo counties, T. P. Pendleton and D. S. Birkett ran 73 miles of primary levels and established 20 permanent bench marks. L. F. Biggs completed a precise level line across the Tehachapi Pass from Bakersfield to San Pedro, 143 miles being run and 9 permanent bench marks established in order to check elevations previously established so as to determine possible earth movement.

California-Nevada.—The mapping of the White Mountain quadrangle, lying partly in the Inyo and Mono national forests, in Mono County, Cal., and Mineral and Esmeralda counties, Nev., was completed, the area mapped being 292 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 136 square miles is in the national forests, 239 square miles in California, and 53 square miles in Nevada.

Nevada.—The resurvey of the Manhattan mining district, in Nye County, was completed by A. T. Fowler, the area mapped being 38 square miles, for publication on the scale of 1:24,000, with a contour interval of 25 feet. For the control of this area Mr. Fowler occupied 8 triangulation stations and marked 5. For the control of the Pioche district, in Lincoln County, and of the Carson Sink and Wadsworth quadrangles, in Churchill County, D. S. Birkett and T. P. Pendleton ran 151 miles of primary levels and established 39 permanent bench marks, of which 7 miles and 1 mark were in the Utah portion of the Pioche quadrangle.

Utah.—The survey of the Logan quadrangle, lying partly in the Cache National Forest, in Cache, Boxelder, and Rich counties, was completed by H. H. Hodgeson, the area mapped being 507 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 100 feet. Of this area 187 square miles is in the national forest. In connection with the mapping of the Logan quadrangle profile surveys of Logan and Blacksmith Fork rivers were made by Mr. Hodgeson, the distance traversed being 37 linear miles, for publication on the scale of 1 : 48,000, with a contour interval of 25 feet. The resurvey of the Vernal, Wellington, and Castle Gate quadrangles, in Uinta and Carbon counties, was completed by E. R. Bartlett and Cornelius Schnurr, the total area mapped being 397 square miles—167 square miles for publication on the scale of 1 : 125,000, with a contour interval of 100 feet, and 230 square miles for publication on the scale of 1 : 62,500, with a contour interval of 50 feet. For the control of the Castle Gate quadrangle Mr. Schnurr ran 42 miles of primary levels and established 10 permanent bench marks. (See also Nevada, p. 133.)

Hawaii.—To complete the cooperative topographic work begun under the agreement for the fiscal year 1914 the Territory of Hawaii allotted $837.35 and the United States Geological Survey allotted $305. The survey of the island of Hawaii was continued, the area mapped being 19 square miles, for publication on the scale of 1:31,680, with a contour interval of 10 feet. This work, which was done by A. T. Fowler, completed the mapping of the Hilo 15-minute quadrangle.

OFFICE WORK.

The drafting of the following sheets was completed: Gila Butte, Pearce, and San Simon, Ariz.; Ceres, Copperopolis, Cressy, Crows Landing, Denair, Riverbank, Klamath River, Mare Island, Merced, Mitchell School, Hopeton, Salmon River, Santa Rosa, Sawyers Bar, Scott River, Seiad, Stanislaus River, Turlock, Waterford, and Winton, Cal.; San Francisco and vicinity (revision), Cal.; Manhattan mining district and Yerington mining district, Nev.; Blacksmith Fork River, Castle Gate, Duchesne River, Green River, Logan, Logan River, Uinta River, Vernal, Wellington, and White River, Utah.

Progress in the mapping of additional sheets was made as follows: White Mountain, Cal.-Nev., 70 per cent; Hilo, Hawaii, 74 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Christmas, Maricopa, and Pearce quadrangles (Ariz.), the Nutrioso and San Simon quadrangles (Ariz.-N. Mex.), the Bridgeport, Copperopolis, Elizabeth Lake, Mount Lyell, and Mount Morrison quadrangles, and the San Joaquin Valley (Cal.), the Aura, Carson Sink, Delamar, Elko, Kumiva, Panaca, Pyramid, Reno, and Wadsworth quadrangles (Nev.), and the Castle Gate (Utah) quadrangle.

Precise leveling was adjusted for new lines from Kern via Mohave to Orange and from Florence to San Pedro, Cal., and for old lines from Benicia to Kern and from Barstow to Mohave, Cal.

Geographic positions were computed for the Santa Rosa (Cal.), Hilo (Hawaii), Vernal (Utah) quadrangles and for the Mitchell School, Turlock, Cressy, Winton, Hopeton, Stevinson, No. VIII, Atwater, Merced, Planada, Mariposa Slough, and Owens Creek (Cal.) 7½-minute quadrangles.

SECTION OF FIELD EQUIPMENT.

During the year 1914 a section of field equipment was organized for the custody of all field equipment of the three field branches of the Survey. The personnel of the section consists of E. M. Douglas, two clerks, and one laborer.

During the year this section received and recorded all incoming field instruments and supplies, and packed and shipped all outgoing instruments. The custody of topographic notebooks and field records was assigned to the section, as well as the general supervision of instrument repair work in the Survey instrument shop. With the exception of extensive repairs to such instruments as aneroid barometers, leveling rods, cameras, and microscopes, for which the Survey shop is not at present fitted, the shop, under the immediate charge of Ernest Kübel with one assistant, made repairs or alterations to more than 2,000 different articles, including 205 standard telescopic alidades, 53 Gale alidades, 62 Y levels, 12 transits, 11 theodolites, 175 box compasses, 119 Brunton and other compasses, 50 tally registers, and 133 sight alidades. The instrument shop also made, resurfaced, or electrotyped over 140,000 square inches of plates.

INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

J. H. Renshawe spent two months in inspecting field work in the Atlantic division. W. M. Beaman visited topographic parties in the central, Rocky Mountain, and northwestern divisions and made frequent field inspections of the work on the large-scale map of Washington, D. C., and vicinity. A. M. Walker inspected field parties in the Atlantic and central divisions. Mr. Beaman spent one month and Mr. Walker two months in field work on the Washington and vicinity map.

The office duties of Messrs. Beaman and Walker included supervision of the inking of all topographic field sheets and office preparation of river-profile and land-classification sheets and reports and final examination of them prior to photolithography, engraving, and proper transmission; also attention to the referred matter of a technical nature pertaining to the branch as a whole rather than to any particular topographic division. Mr. Beaman's office duties also included special attention to river-profile surveys, the supervision of the map of Washington and vicinity, and cooperation with M. R.

Campbell in the preparation of a set of 50 topographic sheets illustrating physiographic and engineering features for the use of schools and in the selection and description of an exhibit of topographic sheets for the Panama-Pacific Exposition at San Francisco.

Mr. Renshawe's entire office time was spent in preparing colored relief maps of national parks and in similar work, as reported in detail on page 107.

MILLIONTH-SCALE MAP OF THE UNITED STATES.

Of the work in progress last year on the 1 : 1,000,000 scale map of the United States, under the direction of A. F. Hassan, the base map of Oregon (portions of sheets K–10, K–11, L–10, and L–11) was completed, as was the contouring of sheet K–18. New work included the adjustment of 35 per cent of the township lines and 20 per cent of the compilation and inking of the base map of Idaho (portions of sheets K–11, K–12, L–11, L–12, and M–11), the completion of the base map of the Navajo country, Arizona, and New Mexico (portions of sheets I–12, I–13, J–12 and J–13), and the compilation and inking of the contours for 60 per cent of sheet J–18, 80 per cent of sheet J–17, 15 per cent of sheet J–16, 40 per cent of sheet J–15, 25 per cent of sheet I–17, 40 per cent of sheet I–16, 20 per cent of sheet I–15, and 65 per cent of the United States portion of sheet K–17. Roads were compiled and inked for 30 per cent of sheet J–17, for 75 per cent of sheet J–18, and for 25 per cent of sheet K–18.

Three tracings and 21 maps were also prepared for the Bureau of Fisheries, all the expenses of the work being borne by that bureau.

Tracings of six sheets of an enlargement of the map of San Luis Valley, Colorado, were also prepared for the Reclamation Service.

WATER-RESOURCES BRANCH.

ORGANIZATION AND SCOPE OF WORK.

The water-resources branch includes three divisions—surface water, ground water, and water utilization—each of which is subdivided into sections for field work. The organization is as follows:

Chief of branch, N. C. Grover, chief hydraulic engineer.
Division of surface waters, John C. Hoyt, hydraulic engineer, in charge.
Division of ground waters, O. E. Meinzer, geologist, in charge.
Division of water utilization, N. C. Grover, chief hydraulic engineer, in charge.

PERSONNEL.

During the year the technical force of the water-resources branch has been reduced 10 by transfers, resignations, and deaths and has been increased 9 by new appointments. At the end of the year the force consisted of 1 chief hydraulic engineer, 12 hydraulic engineers, 28 assistant engineers, 25 junior engineers, 1 hydrographer, 1 geologist, 1 associate geologist, 3 assistant geologists, 1 geologic aid, 1 chemist, 1 assistant chemist, and 1 junior chemist, a total of 76. Of this number, 1 hydraulic engineer, 3 assistant engineers, 1 assistant chemist, and 3 junior engineers are on furlough; and 1 hydraulic engineer, 1 hydrographer, 3 assistant engineers, and 1 assistant geologist are employed occasionally.

In the clerical force there were 2 separations and 3 accessions. At the end of the year the force consisted of 2 senior clerks, 1 clerk, 9 junior clerks, 9 under clerks, 1 copyist, 1 stenographer, 1 clerk-stenographer, 1 draftsman, and 1 messenger boy.

ALLOTMENTS.

The appropriation was the same as in the preceding year ($150,000). The cooperative funds made available by State allotments have been increased in some States and decreased in others, making necessary corresponding adjustments of the work.

The appropriation for the fiscal year was allotted as follows:

Allotments of appropriation for investigation of water resources, 1914–15.

Administrative expenses of the Survey		$10,344
Branch administration		8,250
Computations and reports		17,000
Inspection		1,500
Stream gaging in—		
New York and New England States	$5,650	
Virginia and Maryland	600	
South Atlantic and Gulf States	5,500	
Ohio Valley	6,000	
Upper Mississippi Valley States	5,000	
Colorado and Wyoming	6,500	
Montana	4,500	
North Dakota	300	
Utah	4,500	
Nevada	2,500	
Idaho	4,500	
Oregon	4,500	
Washington	4,500	
California	4,500	
New Mexico	4,500	
Arizona	3,000	
Hawaii	5,000	
Yellowstone National Park	200	
		71,750
Investigation of ground waters, including quality of waters		17,500
Land-classification board		11,000
Water-power investigations		11,000
Contingent		1,656
		150,000

Of the total appropriation, 64 per cent was allotted for work in public-land States.

COOPERATION.

States.—Cooperative funds were allotted by several States as follows:

Amounts allotted by States for cooperative work with United States Geological Survey in investigation of water resources.

Alabama		$170
Arizona		3,900
California—		
State engineer	$6,700	
Conservation commission	1,300	
City of San Diego	1,000	
City of San Francisco	4,200	
		13,200
Colorado		480
Connecticut		1,000
Hawaii		15,400
Idaho		1,900
Illinois		3,400
Iowa		450
Kentucky		670
Maine		75
Massachusetts		3,350
Minnesota		2,100
Montana		2,500
Nevada		1,800
New Mexico		7,200
New York—		
State engineer	$1,400	
Conservation commission	10,500	
		11,900
North Dakota		350
Oregon		11,000
South Dakota		960
Utah		4,100
Vermont		900
Washington		5,950
West Virginia		400
Wisconsin		8,800
Wyoming		1,600
		103,555

The work done under cooperative agreements in the several States has been limited to stream gaging, except as indicated below.

In addition to a large amount of stream gaging in California, investigations of ground water were made in San Diego County and in Sacramento and Santa Clara valleys, and measurements of depths to the ground-water level were made in southern California.

In Connecticut the cooperative work consisted chiefly of ground-water surveys.

In Hawaii, besides stream gaging, measurements of precipitation and studies of water losses in irrigation canals were made.

A compilation of stream-flow records in Oregon is now in press.

A detailed study of the water supply and the present and possible future use of Sevier River, Utah, begun in 1914, was still in progress at the end of the fiscal year.

In addition to the cooperative work tabulated above, in which the States have furnished part of the money for examinations made by the Survey staff, investigations of ground waters in cooperation with the agricultural experiment stations of New Mexico and Arizona were continued as in previous years, the experiment stations making analyses of samples of water and soluble salts collected.

Reclamation Service.—Cooperation with the Reclamation Service in stream gaging has been continued. The gaging stations operated at the expense of the reclamation fund are on streams that are to furnish water to reclamation projects under construction by that Service. The field work of stream gaging is done by Survey engineers who are engaged in such work in the locality, and repayment of actual cost is made by the Reclamation Service through a transfer of funds.

Office of Indian Affairs.—Investigations and reports have been made at the request of the Commissioner of Indian Affairs in connection with the classification of lands within Indian reservations with regard to water-power and reservoir sites and for the purpose of locating ground-water supplies, as follows:

The investigation of the occurrence and availability of ground water in the Hopi and Navajo reservations was completed during the year, and a report was prepared for publication.

A report was made on the possibility of developing water power on Hogback Canal, in T. 12 N., Rs. 1 and 2 W., and T. 13 N., R. 2 W., New Mexico meridian, in the Navajo Reservation.

An investigation was made to determine the practicability of developing ground-water supplies for irrigation on the San Carlos Reservation.

A report was made on the power-site and reservoir possibilities on the Wind River Reservation.

Stream gaging was continued on the following Indian reservations, in accordance with authorizations of the Office of Indian Affairs: Colville, Crow, Fort Hall, Klamath, La Pointe, Menominee, Pine Ridge, Queniult, Rosebud, San Carlos, Standing Rock, Warm Springs, and Yakima.

Public Health Service.—Special stream-gaging work in cooperation with the Public Health Service in connection with an investigation of the pollution of Ohio River, begun in the previous year, was completed.

United States Engineer Office.—Stream gaging in connection with navigation and flood studies in the Ohio basin is in progress in cooperation with the United States Engineer Office.

City of San Francisco.—Stream gaging is in progress on Tuolumne River, in cooperation with the city of San Francisco, in connection with the utilization of the water of that river, to be stored in the Hetch Hetchy Valley as a water supply for the city.

PUBLICATIONS.

The publications prepared by the water-resources branch comprised 33 water-supply papers and 18 separate chapters. Titles and brief summaries of these publications are given on pages 27–35. At the close of the year 24 other reports were in press and 6 manuscripts were in hand awaiting editing.

GENERAL SUMMARY.

In the investigation of surface waters the water-resources branch has maintained 1,350 gaging stations for measuring the discharge of streams in 41 States and Hawaii. It is, however, only through extensive cooperation with States and other Federal organizations that the relatively large amount of work now in progress can be carried on. Twenty-six cooperating States (including Hawaii) have contributed more than $100,000 for work in those States, and the Reclamation Service, Indian Office, Army Engineers, and Public Health Service have also cooperated, largely in the study of the flow of particular rivers. The cooperating States include many Northern and Eastern States and all the States in the Rocky Mountain, Great Basin, and Pacific groups where water is necessary for agriculture by irrigation. At the close of the year gaging stations were being maintained at 1,350 points, including 129 in Hawaii. In addition, records were received from about 250 stations maintained by private enterprises. The resulting records of river discharge are published in an annual progress report consisting of 14 water-supply papers and in special water-supply papers.

Investigations of ground water have been made in 12 States, but the lack of funds prevents the comprehensive study of the occurrence, quantity, and quality that is commensurate with the importance of such water. This work should be greatly extended, especially in those sections of the arid States where further agricultural development can be made only by use of ground water. Several water-supply papers are published yearly containing the results of ground-water investigations.

Many investigations of the present and probable future use of both surface and ground waters have been made in connection with the classification of the public lands, with special reference to their use for power under permit or for agriculture under the enlarged-homestead, desert-land, or Carey acts. The results of such investigations appear generally in unpublished special reports to the Commissioner of the General Land Office and to the Secretary of the Interior.

G. K. Gilbert, geologist, who has worked under the joint auspices of the geologic and water-resources branches, revised and enlarged his report on the "Hydraulic mining débris of the Sierra Nevada, California." The field work necessary for this revision consisted of two series of current observations—one series made in the Golden Gate opposite Fort Point, for the purpose of ascertaining certain tidal constants which affect the estimates of movements of mining débris delivered by the rivers to the San Francisco Bay system, and one series made in a slough near Ravenswood, Cal., for the purpose of determining the quantity of tidewater received and delivered by marshlands. Mr. Gilbert received important aid in these observations from the Lighthouse Service, the United States Army engineers, and the United States Coast and Geodetic Survey.

DIVISION OF SURFACE WATERS.

ORGANIZATION.

The work of the division of surface waters consists primarily of the measurement of the flow of rivers, but includes also special investigations of conditions affecting stream flow and utilization of the streams. In carrying on the work the United States is divided into 16 districts, including Hawaii. Two of these districts were established during the year—New England, which was formed by dividing the North Atlantic district, and Arizona, which was formed by dividing the Arizona and New Mexico district. The New Mexico district was discontinued on June 30, 1915, and the work consolidated with that of the Rocky Mountain district. The following list gives the districts, names of the district engineers, and location of offices:

New England: C. H. Pierce, Customhouse, Boston, Mass.
New York: C. C. Covert, Federal Building, Albany, N. Y.
Middle Atlantic: G. C. Stevens, Washington, D. C.
South Atlantic and eastern Gulf: Warren E. Hall, Federal Building, Atlanta, Ga.
Ohio Valley: A. H. Horton, Federal Building, Newport, Ky.[1]
Upper Mississippi River: W. G. Hoyt, Capitol Building, Madison, Wis.; suboffice, Old Capitol Building, St. Paul, Minn.
Upper Missouri: W. A. Lamb, Montana National Bank Building, Helena, Mont.
Rocky Mountain: Robert Follansbee, Chamber of Commerce Building, Denver, Colo.
Great Basin: E. A. Porter, Federal Building, Salt Lake City, Utah.
Idaho: G. C. Baldwin, Idaho Building, Boise, Idaho.
Oregon: Fred F. Henshaw, Couch Building, Portland, Oreg.
Washington: G. L. Parker, Federal Building, Tacoma, Wash.
California: H. D. McGlashan, Customhouse, San Francisco, Cal.; suboffice, Federal Building, Los Angeles, Cal.
Arizona: C. C. Jacob, 417 Fleming Building, Phoenix, Ariz.
New Mexico: G. A. Gray, Capital City Bank Building, Santa Fe, N. Mex.
Hawaii: G. K. Larrison, Kapiolani Building, Honolulu.

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[1] Office temporarily closed during the year; work conducted from Washington office.

CHARACTER AND METHODS OF WORK.

Field investigations incident to the work are made from the district offices, where the results are sufficiently analyzed to insure their accuracy and completeness. At selected places, known as gaging stations, measurements of discharge are made and other data are collected from which the daily flow of the streams is computed. At the end of the year 1,350 gaging stations were maintained. During the year 408 stations were discontinued and 412 stations established. In addition, records ready for publication were received for about 250 stations from other Government bureaus and private persons. During the year 8,040 measurements of discharge were made. Many of the stations are maintained in cooperation with other Federal bureaus, State organizations, or private persons.

The following table shows the distribution of the stations and measurements by States and the number of stations maintained by cooperating parties:

Report of gaging stations and cooperating parties for the year ending June 30, 1915.

State.	Geological Survey alone.	Reclamation Service.	Forest Service.	Indian Office.	Army Engineers.	Weather Bureau.	Other Federal bureaus.	State cooperation.	Municipal cooperation.	Private persons.	Counted more than once.	Maintained at end of year.	Established during year.	Discontinued during year.	Regular gagings during year.	Miscellaneous gagings during year.
Alabama					1			4				5		1	6	
Arizona		3		4	2			18		2	4	25	1	2	432	34
California		7	41	2		2	3	166	14	55	119	171	21	13	1,225	196
Colorado	3		29			1		12		5	2	48	6	18	208	3
Connecticut								1				1	1	2	14	2
Georgia	2					4			3	11	2	18	6		88	6
Idaho	5	10	7	10		3			1	28		64	3	32	303	41
Illinois						1		24				25	30	6	158	8
Indiana						1				1		2	1		1	1
Iowa						2		14			2	14	13	10	32	
Kentucky						1		5				6	5		7	4
Maine								14		8		22	25	3	19	
Maryland	3											3			19	
Massachusetts								11		7	1	17	7	2	84	20
Michigan								1	1	3		5				
Minnesota					2	2	1	28		1	6	28	4	13	111	1
Montana	11	55	16	7		1	2	20		1	1	112	2	16	385	25
Nebraska														13		
Nevada		5		2		1		38		15	19	42	21	39	286	97
New Hampshire										5		5	1		14	
New Jersey	1											1		1	1	
New Mexico		6	2	2				10		11	1	30	3	41	362	5
New York					1	3		40	1	5	10	40	3	3	264	58
North Carolina	2					1				8		11		1	9	
North Dakota				1				7				8			32	
Ohio	1				5		1		1			8	5	1	17	6
Oklahoma		4										4	1		2	
Oregon	5	1	4	5	1	4	1	20	3	44		88	31	45	345	169
Pennsylvania														3	2	4
Rhode Island										1		1	1			
South Carolina							1					1	1		14	
South Dakota				4				2				6	3	2	55	2
Tennessee	2					3				4		9	4		21	5
Texas	2	4				6			1			13	10	1	115	8
Utah		4	2					132		83	89	131	83	95	938	86
Vermont								7		2	1	8	4	6	36	8
Virginia	8					1				4		13	1	1	24	
Washington	7	22	8	12			2	6	1	31	1	88	18	20	378	32
West Virginia	18				13	1		7				39	16	1	71	4
Wisconsin				3	1			46		15	19	46	8	4	297	3
Wyoming		6	1			1	4	54			2	63	50	3	158	14
Hawaii					3			129		56	59	129	23	10	496	169
Total	70	127	110	52	29	39	15	816	26	406	338	1,350	412	408	7,029	1,011

NOTE.—Total for Hawaii June 30, 1914, should have been 116 instead of 141.

Results of field data collected from the district offices are transmitted to the Washington office, where they are reviewed in the computing section and prepared for publication. This review insures accuracy in the data and brings the results from different parts of the country to a uniform standard. Regular field inspections are made and annual conferences of the engineers are held, whereby the work in the several districts is standardized.

PUBLICATIONS.

For convenience and uniformity in publication the United States has been divided into 12 primary drainage basins, as shown in the following table, and the results of stream measurements are published annually in a series of progress reports that correspond to these 12 divisions. Prior to 1914 the records for each division were contained in a single water-supply paper; beginning with 1914 the reports for the twelfth division will be published as three separate papers.

In 1913 a seasonal or climatic year—October 1 to September 30—was adopted for the presentation of reports on regions west of the Rocky Mountains and on upper Mississippi and Ohio rivers; in 1914 the use of the climatic year was extended to all districts.

Numbers of water-supply papers containing results of stream measurements, 1910–1914.

Part—	Area.	1910	1911	1912	1913	1914
I	North Atlantic	281	301	321	351	381
II	South Atlantic and eastern Gulf of Mexico	282	302	322	352	382
III	Ohio River	283	303	323	353	383
IV	St. Lawrence River and Great Lakes	284	304	324	354	384
V	Hudson Bay and upper Mississippi River	285	305	325	355	385
VI	Missouri River	286	306	326	356	386
VII	Lower Mississippi River	287	307	327	357	387
VIII	Western Gulf of Mexico	288	308	328	358	388
IX	Colorado River	289	309	329	359	389
X	Great Basin	290, 291	310	330	360	390
XI	California	291	311	331	361	391
XII	North Pacific	292	312	332	362	....
	Pacific basins in Washington and upper Columbia River	....	....	332–A	362–A	392
	Snake River basin	....	....	332–B	362–B	393
	Lower Columbia River and Pacific basins in Oregon	....	....	332–C	362–C	394

In addition to the regular progress reports, special reports on various hydraulic subjects have been completed for publication during the year, as is indicated in the list on pages 27–35.

DIVISION OF GROUND WATERS.

SCOPE OF WORK.

The main function of the division of ground waters is to make a survey of the underground waters of the country with reference to their utilization. The investigations of each year form part of a comprehensive plan that includes the entire country. Because of the great interest throughout the West in irrigation with ground water and the prospects for considerable developments of this kind, most of the work has been done in the arid and semiarid States and with special reference to irrigation.

The chemical investigations, which are under the supervision of R. B. Dole, cover both surface and ground waters. Progress was made in the preparation of a comprehensive report on the chemical composition of the surface waters of the United States by Mr. Dole, assisted by E. C. Bain, C. D. Parker, and A. A. Chambers. The chapter on the production of mineral waters for the annual volume Mineral Resources of the United States, with a history of the mineral-water trade of the United States since 1883, was prepared by Mr. Dole. Maps and manuscripts for geologic folios were reviewed so far as they related to ground water.

Nearly 40 investigations of ground water or quality of water (including the reports in press) were in progress, covering areas in Arizona, Arkansas, California, Connecticut, Florida, Georgia, Idaho, Maine, Mississippi, Montana, Nevada, New Mexico, Oregon, Texas, and Washington. The work in Arkansas, Florida, Georgia, Mississippi, and Texas was done in cooperation with the section of Coastal Plain investigations of the geologic branch, and the work in Idaho was done by the division of water utilization. During the year 11 reports were completed and 10 were published.

WORK BY STATES.

Arizona.—A comprehensive report on the ground water of the Hopi and Navajo Indian reservations, in Arizona and adjacent parts of New Mexico and Utah, was completed by H. E. Gregory, who has been in charge of the investigation since its beginning in 1909. The report will be published as Water-Supply Paper 380. The ground-water conditions of an area west of Little Colorado River have also been investigated by Prof. Gregory, and a report covering the area is in preparation. Both investigations were made in cooperation with the Office of Indian Affairs.

By direction of the Secretary of the Interior, an investigation of the ground water in Paradise Valley, with special reference to its utilization for irrigation, was made by O. E. Meinzer and A. J. Ellis. A report on this investigation was completed and sent to press to be published as Water-Supply Paper 375–B. Analyses of water from this valley were made by the Arizona Agricultural Experiment Station.

An investigation of the ground water in the San Carlos Reservation with respect to its availability for irrigation was undertaken for the Office of Indian Affairs by A. T. Schwennesen, who completed the field work and is now preparing a report.

A short time was spent by Mr. Schwennesen in the San Simon Valley for the purpose of obtaining data on the yield and pressure of artesian wells in that valley. The San Simon investigation was begun in 1913 and was resumed in the summer of 1915. The water analyses are made by the Arizona Agricultural Experiment Station, through the cooperation of R. H. Forbes, director.

Arkansas.—The report on the geology and underground-water resources of eastern and northeastern Arkansas, by L. W. Stephenson and A. F. Crider, with a discussion of the chemical character of the waters by R. B. Dole, was completed by the authors before the beginning of the fiscal year and is being prepared for the printer. It is to be published as a water-supply paper.

California.—A comprehensive report on the springs of California, by G. A. Waring, was published as Water-Supply Paper 338. It is based on extensive field work done by Mr. Waring in earlier years.

The field work for the ground-water survey of the Sacramento Valley, which was begun in September, 1912, was continued by Kirk Bryan, assisted by J. W. Muller, and was completed about January 1, 1915. A preliminary report by Mr. Bryan on ground water for irrigation in the Sacramento Valley was published as Water-Supply Paper 375–A, and considerable work was done on the maps and manuscript for the final report on the region.

Good progress was made during the year by W. O. Clark in the ground-water survey of the Santa Clara Valley, on which he has been engaged since August, 1912. A report on the ground-water resources of the Niles cone, which is a part of the Santa Clara Valley, was prepared by Mr. Clark and was published as Water-Supply Paper 345–H.

The final report on ground water in the San Joaquin Valley, by W. C. Mendenhall, R. B. Dole, and Herman Stabler, was completed and sent to the printer to be published as Water-Supply Paper 398. Some work was also done by W. C. Mendenhall and G. A. Waring on the San Jacinto Valley investigation.

An investigation of the ground-water resources of the part of San Diego County lying west of the divide was undertaken by A. J. Ellis and C. H. Lee, and most of the field work and considerable of the office work was completed. The results are to be embodied in a comprehensive report on the water resources of the county. The analytical work was done by S. C. Dinsmore. Financial cooperation was furnished by the city of San Diego.

Since 1900 measurements of depths of the water level in a series of wells in southern California have been made at intervals for the purpose of obtaining a record through many years of the relations between the contributions to the underground reservoirs in the rainy seasons and the withdrawals from them in the dry seasons, when ground water is pumped for irrigation and when evaporation and transpiration are most rapid. Most of the records for the period prior to 1909 have been published in Water-Supply Papers 213 and 251; the records for 1909, 1910, and 1912, together with a brief discussion by W. C. Mendenhall, were published during the year in Water-Supply Paper 331. The work is at present being carried on by F. C. Ebert, who has selected companion wells and otherwise improved the methods. Mr. Ebert has also made progress in the tabulation of all available water-level data for the region.

All the ground-water work in California is supported by financial cooperation of the State Department of Engineering.

Connecticut.—The report on ground water in the Hartford, Stamford, Salisbury, Willimantic, and Saybrook areas, by H. E. Gregory and A. J. Ellis, which was completed before the beginning of this fiscal year, is now in press as Water-Supply Paper 374.

The report on ground water in the Waterbury area, by A. J. Ellis, was completed during the year and was sent to the printer to be published as Water-Supply Paper 397.

An investigation of the relations between precipitation, ground-water storage, evaporation, and run-off in the Pomeraug Valley, begun in July, 1913, by A. J. Ellis, was continued, observations being made regularly during the year and the data tabulated and plotted.

A ground-water survey of the Meriden area was made by G. A. Waring, and 25 samples of water were collected for mineral analysis.

A ground-water survey of the Plainville area was made by H. S. Palmer, and at the close of the year work was in progress in other towns in the northeastern section of the State.

All the work in Connecticut is done in cooperation with the State Geological and Natural History Survey, W. N. Rice, superintendent, and is under the supervision of H. E. Gregory. The results of the various surveys will be published in water-supply papers.

Florida.—Some progress was made during the year on the investigation of the quality of ground waters in Florida, and work on this project is to be resumed by Mr. Dole in the near future. Daily samples of sea water from Fowey Rocks Light were tested for chlorine content in connection with Mr. Vaughan's study of oceanographic phenomena on the Florida coast.

Georgia.—The report on the ground waters of the Coastal Plain of Georgia, by L. W. Stephenson and J. O. Veatch, with a discussion of the chemical character of the waters by Mr. Dole, was published as Water-Supply Paper 341. The investigation on which this report is based was conducted in cooperation with the Georgia Geological Survey.

Idaho.—An investigation of the ground water in the Fort Hall Indian Reservation was made by W. B. Heroy, and a report prepared by him was incorporated in a general paper on the geology and resources of the region which is to be published as a bulletin.

At the request of the division of drainage investigations, Department of Agriculture, an examination of water-level problems on irrigated lands in the vicinity of Twin Falls was made by Mr. Heroy, and a manuscript report by him on the causes and cure of the rising water levels was transmitted to the Department of Agriculture.

Maine.—At the request of the Secretary of the Navy, a brief examination of available water supplies in the vicinity of the Portsmouth Navy Yard was made by O. E. Meinzer.

Mississippi.—The division of ground water continued its cooperation with the section of Coastal Plain investigations of the geologic branch in the general investigation of ground water in Mississippi. (See pp. 50–51.) The analytical work was supervised by Mr. Dole.

Montana.—The report on the water resources of Butte, Mont., by O. E. Meinzer, was published as Water-Supply Paper 345–G.

Through the cooperation of the division of surface waters and A. W. Mahon, State engineer of Montana, steps were taken near the close of the year to collect the records of the most important wells in the State.

Nevada.—The report on ground water in southeastern Nevada by Everett Carpenter was published as Water-Supply Paper 365.

Additional field work was done by O. E. Meinzer in Big Smoky Valley, chiefly on the contributions of the streams to the underground supply. A preliminary report on this valley was prepared and sent to the printer to be published as Water-Supply Paper 375–D. The final report on the geology and water resources of Big Smoky, Clayton, and Alkali Spring valleys was completed by Mr. Meinzer. The chemical work was done by S. C. Dinsmore.

Near the close of the year an investigation of water levels on the Truckee-Carson project was undertaken for the Department of Justice by C. H. Lee and W. O. Clark.

New Mexico.—The report on the Tularosa Basin and adjacent areas, by O. E. Meinzer and R. F. Hare, prepared in cooperation between the New Mexico Agricultural Experiment Station and the Survey, was published as Water-Supply Paper 343.

Work on the ground-water resources of southern Grant County, including the Animas, Playas, and Hachita valleys, was continued by A. T. Schwennesen, of the Survey, and Mr. Hare, of the experiment station, and at the close of the fiscal year the report was nearly completed.

The report on ground water in the Hopi and Navajo reservations, by H. E. Gregory, covers a part of northwestern New Mexico. (See Arizona, p. 144.)

A number of samples of water collected by Mr. Schwennesen in Luna County were analyzed by Mr. Hare at the experiment station.

Oregon.—The report on the quality of surface waters of Oregon, by Walton Van Winkle, prepared in cooperation with J. H. Lewis, State engineer of Oregon, was published as Water-Supply Paper 363.

Texas.—The work in Texas was done in cooperation with the section of Coastal Plain investigations, geologic branch, and was confined to the Coastal Plain.

The report on the geology and underground waters of the southeastern part of the Texas Coastal Plain, by Alexander Deussen, was published as Water-Supply Paper 335.

A report on the ground-water supply of Lasalle and McMullen counties, by Alexander Deussen and R. B. Dole, was completed and is to be published as Water-Supply Paper 375–G.

Work was continued on the ground-water resources of the part of the Texas Coastal Plain not covered by Water-Supply Paper 335, and two papers are being prepared.

Washington.—The report on the quality of the surface waters of Washington, prepared by Walton Van Winkle in cooperation with the State board of health, was published as Water-Supply Paper 339.

DIVISION OF WATER UTILIZATION.

The organization of the division of water utilization has been continued during the year, as described in previous annual reports. E. C. La Rue and E. C. Murphy, hydraulic engineers, have done the greater part of the field work involved in the examination of water-power withdrawals, rights of way, and Carey Act segregations. The work of examining land for designation under the enlarged-homestead act has been done in part by Messrs. La Rue and Murphy and in part by W. B. Heroy, geologist, and W. N. White, assistant classifier, in the land-classification board, who were detailed to the work during a portion of the field season. In addition to routine field work, Mr. La Rue has devoted about six months to the preparation of a manuscript relative to the present and probable future utilization of Colorado River for irrigation, power, and navigation. The report is practically complete and will be published as Water-Supply Paper 395. Mr. Murphy has made a field examination of the possibilities of water-power and reservoir development in Arizona and in the Gila drainage basin in New Mexico in order that lands valuable for such purposes may be designated in accordance with the act of Congress admitting Arizona and New Mexico to statehood. Reports based on these examinations were completed late in the year.

LAND-CLASSIFICATION BOARD.

ORGANIZATION.

Since the land-classification board became a separate branch, on May 1, 1912, its organization and its functions have remained practically stable. The work of the board consists of the receipt from the field branches of the results of investigations made for or adaptable to public-land classification and the transformation of those results into actual classifications, which become the basis of that part of the Department of the Interior's administration of the public-land laws that depends on the character of the lands.

The geologic branch, for example, examines the coal lands of the public domain. The results of the field examination are prepared in accordance with regulations and suggestions formulated by the board and are transmitted to it for use in making reports on the character of the lands or in preparing withdrawals, restorations, or valuations, as may be required. The geologic branch also studies the oil fields of the public domain and likewise reports the results, and after a careful consideration of these results by the land-classification board, the Director transmits to the Secretary of the Interior appropriate recommendations for the creation of petroleum reserves or for their cancellation, or takes any other appropriate action that will assist in the administration of the public-land laws applying to oil.

The topographic branch furnishes a share of the field data that form the basis of classification, not merely by the preparation of general topographic maps and the accompanying classification plats, which permit a study of drainage areas and irrigation possibilities, but by special profile surveys of streams that appear to have power value. These surveys enable the board to make close classification of lands according to their power value, and are valuable in the administration of the laws that control water-power development.

The water-resources branch, by its general work in the gaging of streams, is constantly assembling data essential to the classification of lands both as to power value and as to irrigability. Its groundwater division ascertains facts that are used in the classification required by the enlarged-homestead acts, and its division of water utilization makes examinations that furnish the groundwork necessary for the public-land classifications required by the laws which provide for the disposal of lands through the use of water.

The classifications required by our public-land laws fall into two broad groups—a group dependent on the presence or absence of mineral deposits in the land and a group dependent on the presence or absence of water. The board, in its organization, following this natural grouping of its problems, is composed of two divisions, a division of mineral classification and a division of hydrographic classification. Sections are organized within each division to deal with each of the major subjects with which the division deals. The organization in outline is as follows:

W. C. Mendenhall, chief.

Elsie Patterson, secretary.

Division of mineral classification: Coal section, G. H. Ashley, chairman; E. R. Lloyd, vice chairman. Oil section, M. W. Ball, chairman. Phosphate section, A. R. Schultz, chairman. Metalliferous section, A. R. Schultz, chairman.

Division of hydrographic classification: Section of utilization, Herman Stabler, chairman. Section of classification, W. B. Heroy, chairman.

The staff of the board during the year, although it has varied because of temporary assignments made from time to time, has averaged about 37 persons, of whom 8 are geologists, 8 engineers, 3 draftsmen, 16 clerks of various grades, and 2 messengers. Several changes in the personnel have resulted from assignments of members of the board staff to other branches of the Survey and of assignments to the board to fill vacancies thus created or to take up work not heretofore adequately provided for.

FUNDS.

One of the primary functions of the Geological Survey specifically mentioned in "the organic act" approved March 3, 1879, is the classification of the public lands. Each of the three field branches of the organization, the geologic, the topographic, and the water resources, spends a part of its appropriation in field examinations whose results are submitted to the board for use in official land classification. Specific allotments for the board's office work are made by the Director from the general appropriations. These allotments for the fiscal year 1915 amounted to $58,000 and were distributed among the general appropriations as follows:

Geologic surveys	$31,500
Topographic surveys	11,500
Gaging streams	11,000
Salaries of scientific assistants	4,000
	58,000

GENERAL FEATURES OF THE WORK.

The field examinations made for coal-land classification during the last nine years have covered approximately the following areas in townships, a township comprising 23,040 acres.

Areas examined for coal-land classification by fiscal years from 1907 to 1915, measured in townships.

	Townships.		Townships.		Townships.
1907	296	1910	322	1913	188
1908	583	1911	339	1914	183
1909	443	1912	358	1915	96

The area remaining in coal withdrawals at the end of the fiscal year amounts, roughly, to 2,100 townships, which at the rate of examination this year will require about 22 years for classification.

The classifications of oil, potash, and metalliferous mineral lands during the year have affected smaller areas and the phosphate classifications somewhat larger areas than during preceding years. Most of the public lands in which the possibilities of the existence of valuable deposits of petroleum, phosphate, and potash are considered favorable have already been withdrawn, so that the field work of 1914–15 revealed relatively small additional promising areas, except as to phosphate. The tracing of the phosphate-bearing rocks around the west end of the Uinta Mountains in Utah added considerably to the phosphate territory heretofore known. The greater part of the nonoil and nonpotash lands had been eliminated from the reserves of those minerals as a result of earlier work. Consequently the changes in the areas reserved because of these resources have been relatively slight. Large eliminations were made from the phosphate withdrawals as a result of detailed mapping of parts of the reserves. These changes are summarized in the following table:

Lands withdrawn and restored to entry during the fiscal year ended June 30, 1915.

	Withdrawn.	Restored.
	Acres.	*Acres.*
Oil	197,073	180,818
Phosphate	273,221	454,894
Potash	119,224	2,880

Classification discriminating metalliferous from nonmetalliferous lands during the year covered nearly 1,000,000 acres, chiefly of Indian lands in Washington, Idaho, Arizona, and California. Much the greater part of this area proved to be nonmineral land.

The first great designations of land as nonirrigable for entry under the enlarged homestead acts were made promptly upon the passage of the first act—the act of February 19, 1909 (35 Stat., 639). Large areas were designated during the two succeeding years; small areas were added during 1912 and 1913, when the regulations required that only unpatented lands might be designated; and large areas have been designated during the last two years as a result of the increasing demand and the application of the law to several new States. The gross designations made each fiscal year since the passage of the act are indicated in the accompanying table.

Lands designated as irrigable or nonirrigable during the fiscal years 1909–1915.

	Acres.		Acres.
1909	161,428,184	1913	2,323,612
1910	18,383,201	1914	33,102,289
1911	11,030,598	1915	17,485,259
1912	1,201,513		

The increasing demand for this work and the responses that the board's limited force has been able to make to this demand are indicated in the following table of petitions for designation received during each year since the passage of the act and the number of the requests acted upon:

Petitions for designation of irrigable or nonirrigable lands received and acted on, 1909–1915.

Year.	Received.	Acted on.
1909	80	49
1910	256	145
1911	248	102
1912	511	[illegible]
1913	1,944	945
1914	5,709	5,[illegible]
1915	5,666	3,996

On June 30, 1915, there were 3,327 petitions pending and under consideration.

The changes during the year in the areas withdrawn as valuable for power development have been relatively small, the new withdrawals during the year aggregating 292,134 acres and the restorations 55,646 acres, the total area included in power site reserves at the end of the year being 2,228,105 acres.

SUMMARY.

No coal lands were withdrawn during the year, but 2,363,646 acres were restored, leaving outstanding withdrawn at the end of the year 48,244,274 acres. There was a decrease of 113,088 acres during the year in the area of coal land to which values had been given. This decrease is due to a reclassification as noncoal of certain areas heretofore classified as coal land and appraised. At the end of the year 19,489,771 acres had been valued at an average price of $40.60 an acre.

During the year 197,073 acres of oil land were withdrawn and 180,818 acres of nonoil land eliminated from withdrawals, leaving the net area included in oil withdrawals at the end of the year 4,774,418 acres.

The phosphate classifications during the year resulted in a withdrawal of 273,221 acres and a restoration of 454,894 acres, leaving the net area outstanding at the end of the year 2,660,376 acres.

During the year 119,224 acres were withdrawn for potash explorations and 2,880 acres were eliminated from existing withdrawals, leaving the withdrawn area at the end of the year 342,013 acres. On the basis of containing metalliferous minerals 967,210 acres, chiefly in Indian reservations, were classified. Of this total 929,916 acres were classified as nonmineral and 37,294 acres as mineral land. The new withdrawals of land valuable for power sites during the year amounted to 292,134 acres, the restorations to 55,646 acres, leaving the area withdrawn at the end of the year for this purpose 2,228,105 acres. During the year 17,485,259 acres were classified as nonirrigable and were designated for entry under the enlarged-homestead act. The total area thus designated at the end of the year amounted to 235,596,180 acres.

NEW LEGISLATION.

During the fiscal year that ended June 30, 1915, several acts and amendments to acts were passed which affect the work of classifying the public lands. One of the most important of these was the act of July 17, 1914 (38 Stat., 509), which provides for "the appropriation, location, selection, entry, or purchase" under the nonmineral land laws of all lands withdrawn, classified, or valuable for phosphate, nitrate, potash, oil, gas, or asphaltic minerals with the reservation to the United States of the minerals for which the lands are withdrawn or are valuable. This act supplements the acts of March 3, 1909 (35 Stat., 844), June 22, 1910 (36 Stat., 583), and April 30, 1912 (37 Stat., 105), providing for nonmineral entry on coal lands, and permits agricultural entry and development on practically all lands now included in mineral reserves, which constitute much the greater portion of the total areas withdrawn under the act of June 25, 1910 (36 Stat., 847).

The total area withdrawn on June 30, 1915, was 58,494,844 acres. Of this total all the lands included in coal, oil, phosphate, and potash reserves, aggregating 56,021,081 acres, may now be entered under the nonmineral land laws, the remaining withdrawals of miscellaneous types, aggregating 2,473,763 acres, being not yet subject to agricultural entry. The passage of these acts thus greatly reduced the interference of the withdrawal policy with agricultural development and it can be still further reduced by a provision for agricultural entry of lands in power-site reserves with a reservation of all water-power rights to the Government. Legislation of this type has been advocated by the department, and such a provision has been included in the Ferris bill (H. R. 16673, 63d Cong., 3d sess.).

Four new laws, or amendments to old laws, were passed at the close of the third session of the Sixty-third Congress, which very definitely affect the rights of homesteaders and the procedure under the enlarged-homestead acts. The act of March 3, 1915 (38 Stat., 953), and section 2 of the act of March 4, 1915 (38 Stat., 1163), extended the residence provisions of the enlarged-homestead acts to two additional States, namely, Kansas and South Dakota, so that these acts now apply to 14 States. The amendment of March 3, 1915 (38 Stat., 956), the act of March 4, 1915 (38 Stat., 1162), and section 1 of the act of March 4, 1915 (38 Stat., 1163), constitute a series of supplementary acts which together form important new legislation affecting homesteaders and the administration of the enlarged-homestead laws. Before these acts were passed, homestead entrymen who had received final certificates or patents on 160-acre homesteads were barred from participation in the advantages of the enlarged-homestead laws. Applicants for designations under these laws secured no recognized rights or equities by virtue of their application, and before the desired additional land could be classified it might be acquired under the ordinary homestead laws by another entryman and the applicant under the enlarged-homestead act be left without remedy. The amendment of March 3, 1915 (38 Stat., 956), provides that any homestead entryman who, although he may have submitted final proof or received patent to his entry, still owns and occupies the land entered shall have the right to enter a tract contiguous to the original entry, provided that the two entries together shall not exceed 320 acres in area. Section 1 of the amendment of March 4, 1915 (38 Stat., 1163), provides that an application to enter lands under the enlarged-homestead acts shall operate to reserve these lands from other entry until the Secretary of the Interior shall have determined whether they are subject to acquisition under the enlarged-homestead act. If his decision is favorable and he designates the land, the applicant shall then have a preference right to enter the lands. This series of supplementary laws is completed by the act of March 4, 1915 (38 Stat., 1162), which provides that enlarged homestead entries which were pending on January 1, 1914, but were invalid because title to the original entry had already been acquired under the homestead laws, are validated if the original entry was for less than 160 acres.

Since the act of March 4, 1915, provides that those who desire to secure a preference right to entry, subject to the designation by the Secretary of the Interior of the lands as nonirrigable, must file their applications with the register and receiver of the land district in which the land desired is located, and since the majority of the applicants under the enlarged-homestead laws desire to take advantage of the preference right feature of this law, most of the applications are now received through the General Land Office instead of directly by the Geological Survey or the Secretary's office as heretofore. The General Land Office and the Geological Survey have provided for this new procedure. Regulations have been prepared and issued defining it and a circular on the subject may be obtained at local land offices by applicants who desire to take advantage of this act.

CORRESPONDENCE.

During the fiscal year just closed 19,151 letters were referred to the board, an increase of about 23 per cent over the preceding year. In addition, about 6,000 copies of letters from other bureaus were sent to the board for its information and files. During the same period 18,457 letters, reports, acknowledgments, and notifications were prepared in the board, an average of about 63 incoming and 60 outgoing pieces of mail for each working day of the year.

PUBLICATIONS.

During the year a bulletin entitled "Petroleum withdrawals and restorations affecting the public domain" has been prepared by Max W. Ball and Lucetta W. Stockbridge and submitted for publication. This bulletin gives true and accurate copies of all petroleum withdrawals and restorations. It contains chapters on purpose of the withdrawals, history of the withdrawals, oil-land law, and orders and correspondence, and is illustrated by seven maps. No bulletin of this kind has ever been published, and it is believed that it will be of great value to the Survey, to the Land Office, and to individuals interested in the oil industry in the public-land States.

COOPERATION WITH THE GENERAL LAND OFFICE.

The cooperation between the General Land Office and the Geological Survey through which the Survey's information on the mineral and power value of lands sought under the public-land laws is made available to the department, through the General Land Office, was partly suspended during the fiscal year 1913–14 because the land board's staff and allotments were insufficient to keep the work current. As a consequence of the suspension the cases awaiting action in the Survey were nearly all disposed of by the beginning of the fiscal year 1915 and cooperation was resumed in part soon thereafter. As a result of this resumption, the Survey received during the year 9,046 requests from the General Land Office for information as to the mineral character or the relations to water supplies of public lands sought, and it furnished information in 7,364 cases. It also received 2,710 reports of the field examiners of the Land Office for consideration, and it acted on 2,576 reports of this character.

The following table shows the year's record in the several classes of cooperative cases, including those discussed and including also requests for the designation of lands under the enlarged-homestead act. With the passage of the preference-right act (38 Stat., 1163) and the tendency as a consequence to file enlarged-homestead petitions in the local land offices instead of in the Geological Survey, this type of work comes to resemble more closely, in the manner in which it is handled, the other cooperative work between the two bureaus.

General summary of cooperative cases for the fiscal year 1915.

Classes of cases.	Pending July 1, 1914.	Received during fiscal year.	Disposed of during fiscal year.	Pending June 30, 1915.	Gain (+) or loss (−).
Mineral character only:					
General Land Office requests for information	12	451	283	180	− 168
General Land Office field service reports	85	1,458	1,387	156	− 71
Applications for reclassification as to coal	0	10	9	1	− 1
Applications for classification as to coal	3	18	17	4	− 1
	100	1,937	1,696	341	241
Water resources only:					
General Land Office requests for information	14	125	118	21	− 7
General Land Office field service reports	16	67	65	18	− 2
Cases in national forests	2	67	63	6	− 4
Applications for reclassification as to water resources	13	49	51	11	+ 2
Applications for rights of way	110	460	465	105	+ 5
Lists under Carey Act	0	7	6	1	− 1
Petitions under enlarged-homestead act	1,657	5,666	3,996	3,327	−1,670
Desert-land proofs under irrigation projects	119	151	180	90	+ 29
	1,931	6,592	4,944	3,579	−1,645
Mineral character and water resources:					
General Land Office requests for information	137	7,944	6,382	1,699	−1,563
General Land Office field service reports	60	659	643	76	− 16
General Land Office requests for information as to water resources, accompanied by field service reports as to mineral character	36	526	481	81	− 45
Indian Office requests for information	35	123	148	10	+ 25
	268	9,282	7,654	1,866	−1,598
	2,299	17,781	14,294	5,786	−3,487

MINERAL CLASSIFICATION.

COAL.

Regulations.—The regulations governing the classification and valuation of coal lands approved by Secretary Fisher February 20, 1913,[1] have continued in force during the fiscal year, except that by a decision of Secretary Lane on February 16, 1915, the last part of paragraph 2 was revoked, the department holding that legally classification of coal land must be made by quarter quarter sections and surveyed lots and not by minor subdivisions of 2½ or 10 acres. In the comparatively short time that these regulations have been in force they have proved the soundness of the principles underlying them. Certain modifications may become necessary as knowledge of the chemistry of coal is increased and as further statistics are collected bearing on cost of mining and other factors affecting the value of coal lands. The regulations as they now stand furnish what is believed to be a sound and conservative standard for the classification and valuation of land underlain by coal of any quality or thickness.

Withdrawals and restorations.—No withdrawals of coal land were made during the year. The policy of reducing the outstanding withdrawals was continued in so far as the data available and the demands of other work would permit.

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[1] U. S. Geol. Survey Bull. 537, pp. 96–97, 1913.

Classifications.—During the last year, as in previous years, every effort has been made to obtain information with regard to withdrawn areas which were believed to be largely noncoal land in order that, as rapidly as possible, those areas might be eliminated from the withdrawals. The results in acreage classified—2,902,628 acres—are far below those of previous years, partly because of the previous elimination from withdrawal of the larger noncoal areas and a consequent restriction of field examination to more detailed work on coal lands, but chiefly because of the short season of field work in 1914. Reexamination of parts of Wyoming, Colorado, and Utah which had previously, on very meager evidence, been classified as coal land resulted in the reclassification of large areas, so that the net result of the classifications during the fiscal year is a reduction of outstanding classified coal lands by 24,568 acres.

In the following four tables the results of restorations, classifications, and appraisals during the year are summarized by States:

Coal land restored during the fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	Restorations during fiscal year.	Outstanding June 30, 1915.
Arizona	118,718	....	118,718
California	17,764	121	17,643
Colorado	4,746,663	137,097	4,609,566
Idaho	338,452	....	338,452
Montana	14,203,365	1,204,250	12,999,115
Nevada	83,833	....	83,833
New Mexico	5,549,883	126,228	5,423,655
North Dakota	15,202,533	465	15,202,068
Oregon	26,561	....	26,561
Utah	5,988,064	291,448	5,696,616
Washington	1,380,928	533,036	847,892
Wyoming	2,951,156	71,001	2,880,155
	50,607,920	2,363,646	48,244,274

Coal lands classified and appraised during the fiscal year 1915, in acres.

State.	Total classification.		Reclassification.		Net increase or decrease (shown by minus sign) in outstanding classification.		Coal land appraised.	
	Coal land with and without valuation.	Noncoal.	Coal land reclassified as coal.	Noncoal reclassified as coal.	Coal.	Noncoal.	Total coal land appraised.	Appraised coal land reclassified as noncoal.
California	....	121	....	....	....	121	....	....
Colorado	183,302	226,793	191,544	81,454	− 8,242	145,339	182,487	191,544
Montana	83,635	1,278,744	72,891	1,668	10,744	1,277,076	82,117	72,891
New Mexico	7,073	340,394	5,448	....	1,625	340,394	7,073	5,448
North Dakota	319	40	....	....	319	40	319	....
South Dakota	....	10	10	....	− 10	10	....	10
Utah	1,980	291,686	2,138	80	− 158	291,606	1,980	2,138
Washington	86,867	175,573	....	....	86,867	175,573	640	....
Wyoming	18,039	208,052	133,752	26,595	−115,713	181,457	[a] 18,079	133,752
	381,215	2,521,413	405,783	109,797	− 24,568	2,411,616	292,695	405,783

[a] Includes 40 acres previously classified but not appraised.

Net result of coal-land classification to June 30, 1915, in acres.

State.	Outstanding classification July 1, 1914.		Net result of classifications during fiscal year (decrease in area shown by minus sign).		Outstanding classification June 30, 1915.		
	Coal.	Noncoal.	Coal.	Noncoal.	Coal.	Noncoal.	Total.
Arizona	....	42.492	....	....	....	42,492	42,492
Arkansas	60,715	70,038	....	....	60,715	70,038	130,753
California	8,720	228,381	....	121	8,720	228,502	237,222
Colorado	3,373,389	9,101,579	− 8,242	145,339	[a] 3,365,147	9,246,918	12,612,065
Idaho	2,113	7,936,925	....	....	2,113	7,936.925	7,939,038
Montana	4,844,646	18,910,206	10,744	1,277,076	4,855,390	20.187.282	25,042,672
Nevada	5,880	2,428	....	....	5,880	2.428	8,308
New Mexico	976,419	3,232,564	1,625	340,394	978,044	3.572.958	4,551.002
North Dakota	2,099,324	2,911,631	319	40	2,099,643	2,911,671	5,011,314
Oregon	14,921	1,044,448	....	....	14.921	1,044,448	1,059,369
South Dakota	249,897	6,956,334	− 10	10	[a] 249,887	6,956,344	7,206,231
Utah	1,066,622	2,627,892	− 158	291.606	[a] 1,066.464	2,919,498	3,985,962
Washington	62,073	1,386,098	86,867	175,573	148,940	1,561,671	1,710,611
Wyoming	7,736,838	14,659,271	−115,713	181,457	[a] 7,621,125	14,840,728	22,461,853
	20,501,557	69,110,287	− 24,568	2,411,616	[a] 20,476,989	71,521,903	91,998,892

[a] Decrease in coal areas during fiscal year is due to reclassification as noncoal of land previously classified as coal land.

Valuation of coal lands June 30, 1915.

State.	Appraised coal land July 1, 1914.	Net result of appraisals during fiscal year (decrease in appraised areas during year shown by minus sign).	Total appraised land outstanding June 30, 1915.	Total valuation of appraised coal land.	Average value per acre.
	Acres.	*Acres.*	*Acres.*		
Arkansas	60,715	....	60,715	$1,473,762	$24.20
California	7,720	....	7,720	585,086	75.70
Colorado	2,871,920	− 9,057	[a] 2,862,863	186,110,238	65.00
Idaho	2,113	....	2,113	51,824	24.50
Montana	4,731,621	9,226	4,740,847	116,180,286	24.50
Nevada	5,880	....	5,880	117,600	20.00
New Mexico	958,467	1,625	960,092	21,252,657	22.10
North Dakota	2,099,324	319	2,099,643	34,065,935	16.20
Oregon	4,672	....	4,672	79,259	16.90
South Dakota	249,897	− 10	[a] 249,887	2,756,227	11.00
Utah	1,048,501	− 158	[a] 1,048,343	44,080,759	42.00
Washington	100	640	740	16,000	21.60
Wyoming	7,561,929	−115,672	[a] 7,446,256	385,344,887	51.70
	19,602,859	−113,088	[a] 19,489,771	792,114,520	40.60

[a] Decrease in coal areas during fiscal year is due to reclassification as noncoal of land previously classified as coal land.

Applications for classification and reclassification.—During the fiscal year the Survey received 18 applications for the classification of withdrawn lands either as coal or noncoal land and 10 applications for the revision of outstanding coal and noncoal classifications. Because three of these applications asked for noncoal classification in withdrawn areas regarding which the Survey has no detailed data, and because the evidence submitted by the applicants to show that the land is noncoal was of little value, these requests were not granted. On the other hand, most of the applications for classification as coal land have related to lignite areas, and the applicants have been able to supply sufficient information to warrant the action requested. More than two-thirds of the applications for classification have been granted. The requests for reclassification as noncoal have related mainly to areas of flat-lying beds where, because no coal is exposed on or near the land, claimants have been unwilling to accept the coal classification. Five such applications have been made and denied.

OIL.

The classification of the public lands with reference to their prospective value for deposits of petroleum and natural gas was continued during the year in California and Wyoming.

In California more than 43,000 acres, principally in Kern County, but in part in San Luis Obispo County, were restored to entry, field examination by the Survey having shown these lands to be barren of oil. No withdrawals were made in California during the year. A recomputation of the acreage included in existing withdrawals was made, however, and it indicated that the area reported as outstanding on June 30, 1914 (see Thirty-fifth Annual Report, p. 135), was too small by more than 140,000 acres.

In Wyoming, as a result of geologic evidence obtained by detailed field examination, nearly 130,000 acres were restored in Natrona County and approximately 7,500 acres in Hot Springs County. In Natrona County more than 12,000 acres, and in the Bighorn Basin, in the north-central part of the State, approximately 183,000 acres, were withdrawn as a result of field work by the Survey. The lands withdrawn in the Bighorn Basin lie largely in Hot Springs County, but include also areas in Park County and a small area in Washakie County. There was a net increase during the period of a little less than 60,000 acres in the area withdrawn in Wyoming. The areas withdrawn in Arizona, Colorado, Louisiana, and Utah have not been either increased or decreased during the year.

The following table shows the areas withdrawn during the fiscal year and the total areas included in reserves at its close:

Oil lands withdrawn and restored during the fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	Withdrawals during fiscal year.	Restorations during fiscal year.	Outstanding June 30, 1915.
Arizona	230,400			230,433
California	1,550,848	([a])	43,301	[a] 1,507,547
Colorado	87,474			87,474
Louisiana	414,720			414,720
Utah	1,952,326			1,952,326
Wyoming	522,395	197,073	137,517	581,951
	4,758,163	197,073	180,818	4,774,418

[a] Recomputation of outstanding oil withdrawals in California shows that the areas previously reported should be increased by 140,404 acres.

Of especial interest during the year was the creation of Naval Petroleum Reserve No. 3. This reserve includes 9,481 acres in Natrona County, Wyo., and covers the Teapot dome immediately southwest of the Salt Creek field. This dome is as yet untouched by the drill. The lands included in the reserve were segregated from an outstanding withdrawal, so that its creation did not involve an increase in the acreage of lands withdrawn.

PHOSPHATE.

The classification of phosphate deposits in Florida, Idaho, Utah, and Wyoming was continued during the fiscal year without change in procedure. The regulations governing the withdrawal and restoration of phosphate lands have not been modified since they were adopted by the Survey on March 2, 1912.

Phosphate classification during the fiscal year was based on preliminary examinations in new areas and on detailed examinations in the withdrawn areas. These detailed examinations by the Geological Survey have resulted in material modifications of the outstanding reserves in Idaho and Wyoming. No phosphate examinations were made by the Survey in Florida, but field investigation by the General Land Office resulted in the withdrawal of a small area in that State. Of especial interest is new information, gathered during the year, showing the presence of phosphate on both the north and south sides of the Uinta Range in Utah. The reconnaissance field work in this region led to the withdrawal of additional lands, aggregating 224,558 acres, not previously known to contain phosphate beds.

The results of the phosphate examinations for the fiscal year, in so far as action toward classification has been taken, are set forth in the following summary:

Phosphate lands withdrawn and restored during the fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	Withdrawals during fiscal year.	Restorations during fiscal year.	Outstanding June 30, 1915.
Florida	120,377	120	280	120,217
Idaho	1,001,276	5,678	40,577	966,377
Montana	130,215	....	....	130,215
Utah	36,193	224,558	....	260,751
Wyoming	1,553,988	42,865	414,037	1,182,816
	2,842,049	273,221	454,894	2,660,376

The year's activities resulted in a net reduction of 181,673 acres in the reserves outstanding at the beginning of the year, this figure representing the excess of the restorations over the withdrawals.

POTASH.

Field work by the Survey in search of potash was continued during the fiscal year. As in previous years, the work was largely exploratory. Experimental drilling in old lake basins is being followed by sinking deep exploratory wells. The year's activities resulted in the withdrawal of 119,224 acres in the Smoke Creek Desert, in Nevada, and in the additional restoration of 2,880 acres of unsurveyed lands west of Searles Lake, in California, included in Potash Reserve No. 2, California No. 1, other lands in that reserve having been restored during the preceding fiscal year.

Potash lands withdrawn and restored during the fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	Withdrawals during fiscal year.	Restorations during fiscal year.	Outstanding June 30, 1915.
California	94,087	....	2,880	91,207
Nevada	131,582	119,224	....	250,806
	225,669	119,224	2,880	342,013

METALLIFEROUS LANDS.

The act of February 26, 1895 (28 Stat., 683), made provision for classifying, with respect to their mineral or nonmineral character, the lands within the Northern Pacific Railroad grant in certain land districts in Montana and Idaho, the work to be done by commissioners appointed for the purpose. The classifications made in many areas were unsatisfactory, and a reclassification was provided for in the sundry civil act of June 25, 1910 (36 Stat., 739). At the request of the General Land Office the work is being done by the Geological Survey. Field examination of these lands was first undertaken by the Survey during the field season of 1910. The work was continued during 1911, 1912, 1913, 1914, and 1915 and is nearing completion. The results of the Northern Pacific Railroad classification work for the five years are shown in the following table:

Lands in Northern Pacific Railroad grant in Idaho and Montana classified by the United States Geological Survey, by fiscal years, 1911-1915, in acres.

State.	1911	1912	1913	1914	1915	Total.
Idaho:						
Mineral	45,645	19,144	1,000	....	....	65,789
Nonmineral	90,712	53,055	1,200	....	....	144,967
	136,357	72,199	2,200	....	....	210,756
Montana:						
Mineral	130,386	1,134	19,800	480	6,629	158,429
Nonmineral	21,802	83,981	65,570	7,696	7,911	186,960
	152,188	85,115	85,370	8,176	14,540	345,389
Total:						
Mineral	176,031	20,278	20,800	480	6,629	224,218
Nonmineral	112,514	137,036	66,770	7,696	7,911	331,927
	288,545	157,314	87,570	8,176	14,540	556,145

In addition to the above work, examinations were made of the Colorado Indian Reservation in Arizona and California in 1914 for the Office of Indian Affairs, and classification of the reservation was reported to the Commissioner of Indian Affairs in March, 1915.

During the summer of 1914 an examination of the Snake River gravels in the Fort Hall Indian Reservation was completed by the Survey for the Office of Indian Affairs.

An examination of the Yuma Indian Reservation, in California, during the field season of 1914 resulted in the completion of the mineral classification for the Office of Indian Affairs, and the completed classification has been reported to that office.

During the summer of 1914 the Queniult Indian Reservation, Washington, was examined for the Office of Indian Affairs, and the lands therein were classified and reported on as to their value for all minerals except the oil and gas in a few sections.

Metalliferous classifications made during the fiscal year 1915, in acres.

State.	Mineral.	Non-mineral.	Total.
Arizona	31,934	214,048	245,982
California	5,360	78,338	83,698
Idaho		447,940	447,940
Washington		189,590	189,590
	37,294	929,916	967,210

HYDROGRAPHIC CLASSIFICATION.

WATER POWER.

Withdrawals and restorations.—The classification of the public lands with relation to their value in connection with water power was continued during the year, the withdrawals being made under the authority conferred by the two acts of June 25, 1910 (36 Stat., 847; 36 Stat., 858), and the act of August 24, 1912 (37 Stat., 497). On July 1, 1913, the area included in outstanding withdrawals was 1,898,405 acres. During the year 292,134 acres additional were withdrawn and 55,646 acres previously included in power-site reserves were restored to the public domain. On June 30, 1914, the total area withdrawn in connection with water power was 2,228,105 acres.

The following table shows the action taken during the year and the areas outstanding, classified by States:

Power sites withdrawn, restored to entry, and outstanding, fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	New withdrawals during fiscal year.	Restorations during fiscal year.	Outstanding June 30, 1915.
Alabama	120	....	....	120
Alaska	....	68,200	....	68,200
Arkansas	17,704	....	....	17,704
Arizona	190,431	147,000	....	337,431
California	222,769	33,201	280	555,690
Colorado	270,390	....	....	270,390
Idaho	272,759	5,082	24,868	252,973
Michigan	....	1,240	....	1,240
Minnesota	11,020	....	....	11,020
Montana	157,041	510	2,200	155,351
Nebraska	761	....	....	761
Nevada	19,087	7,224	....	26,311
New Mexico	13,577	....	....	13,577
Oregon	266,710	656	4,040	263,326
Utah	378,147	2,603	18,160	362,590
Washington	97,537	7,507	988	104,056
Wyoming	73,564	18,911	5,110	87,365
	1,991,617	292,134	55,646	2,228,105

Applications for reclassification.—At the beginning of the fiscal year 13 applications for the reclassification of lands included in power-site reserves were awaiting action and during the year 49 were received. Out of this total of 62 cases action was taken on 51, leaving 11 pending at the close of the year.

Right-of-way applications.—Departmental regulations of January 6, 1913, under the act of Congress approved March 4, 1911 (36 Stat., 1253, 1254), and of March 1, 1913, under the act of Congress approved February 15, 1901 (31 Stat., 790), charge the Geological Survey with important administrative duties in connection with applications for rights of way over the public lands for purposes relating to the development of water power. Such applications, when received in proper form at the General Land Office, are now forwarded to the Survey for consideration of such matters as relative priority of applications, incompatibility of works, relative beneficial utilization of resources, and the engineering and economic features involved in the applications and permits. If the approval of an application is found to be compatible with the public interest, a draft of agreement is prepared setting forth terms on which the use of the desired right of way is to be conditioned, and a report is made on the circumstances in the case. On June 29, 1915, the Attorney General held that the act of February 15, 1901, is applicable to the Territory of Alaska, the field for development of power under permit being thereby extended.

In addition to applications for rights of way for hydroelectric development a large number of applications for rights of way of other types are referred to the Geological Survey for consideration and report. These embrace applications for rights of way for railroads under the acts of March 3, 1875 (18 Stat., 482), and March 2, 1899 (30 Stat., 990), affecting public lands and Indian reservations, respectively, on which report is made as to whether or not the construction of the railroad will interfere with power or irrigation development on streams in the vicinity of the right of way; applications for rights of way under the act of March 3, 1891 (26 Stat., 1095), for irrigation uses on which report is made as to interference with power development, the feasibility of the project, and other features; applications for rights of way across national forests for mining, milling, and municipal purposes under the act of February 1, 1905 (33 Stat., 628); and a variety of miscellaneous applications for domestic, municipal, mining, and railroad water supply. The number of each type received and the action taken thereon is indicated in the following table:

Applications for rights of way during the fiscal year 1915.

Classes.	Pending July 1, 1914.	Received during fiscal year.	Acted on during fiscal year.	Pending June 30, 1915.
Railroad: Acts of Congress approved Mar. 3, 1875 (18 Stat., 482), May 13, 1898 (30 Stat., 409), Mar. 2, 1899 (30 Stat., 404), etc.	30	118	119	29
Irrigation: Acts of Congress approved Mar. 3, 1891 (26 Stat., 1095), May 11, 1898 (30 Stat., 404), etc.	16	218	205	29
Power: Acts of Congress approved Feb. 15, 1901 (31 Stat., 790), Mar. 4, 1911 (36 Stat., 1253, 1254), etc.	53	31	45	39
Miscellaneous: Acts of Congress approved Jan. 21, 1895 (28 Stat., 635), May 11, 1898 (30 Stat., 404), May 21, 1896 (29 Stat., 127), Jan. 13, 1897 (29 Stat., 404), Feb. 15, 1901 (31 Stat., 790), Feb. 1, 1905 (33 Stat., 628), Mar. 4, 1911 (36 Stat., 1253, 1254), etc.	11	93	96	8
Total number of applications for original consideration	110	460	465	105
Additional applications for reconsideration	47	67	76	38

NOTE.—The first application received from the Secretary's office was dated Oct. 11, 1909; from the General Land Office Nov. 11, 1909; from the Office of Indian Affairs Dec. 23, 1909.

IRRIGATION.

Reservoir withdrawals.—A number of reservoir sites, valuable principally for the storage of water for irrigation, have been examined by the Geological Survey, and, on its recommendation, the lands they include have been withdrawn from entry. The area included in such withdrawals at the close of the fiscal year is shown in the following table:

Reservoir sites restored to entry during the fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	Restorations during fiscal year.	Outstanding June 30, 1915.
Arizona	33,040		23,040
Montana	15,640		15,640
North Dakota	1,569		1,569
Oregon	10,619		10,619
South Dakota	8,542	8,542	
Washington	35,943		35,943
	95,353	8,542	86,811

Carey Act segregations.—During the year 7 proposed segregation lists under the Carey Act were received for report as to available water supply, general feasibility of plan of reclamation, and mineral character of the lands, and reports on 6 of these lists had been submitted before the fiscal year closed. Supplemental reports on 3 other lists were also furnished.

Irrigation projects.—The Geological Survey, by instructions of the Secretary of the Interior dated March 15, 1913, furnishes to the Commissioner of the General Land Office all information at hand relative to the available water supply and the feasibility of irrigation projects whose water rights or shares are presented as evidence of compliance with the requirements of the desert-land act. During the year 151 such cases were received and 119 were carried over from the preceding year. Of these 270 cases 162 were reported on and 90 were pending June 30, 1914. Supplemental reports were rendered on 18 cases.

ENLARGED HOMESTEADS.

Classification of lands under the enlarged-homestead acts of February 19, 1909 (35 Stat., 639), June 17, 1910 (36 Stat., 531), and June 13, 1912 (37 Stat., 132), was continued during the year. By the act of March 3, 1915 (38 Stat., 953), the enlarged-homestead act was extended to Kansas, and by the act of March 4, 1915 (38 Stat., 1163), to South Dakota, making the act now applicable to 14 States. Designations during the fiscal year have added a large area of land to that previously classified, the added land having been included as a result of investigations of surface and underground water. The following table summarizes the work of the year:

Enlarged-homestead designations during the fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	Designations during fiscal year.	Cancellations during fiscal year.	Outstanding June 30, 1915.
Arizona	24,530,036	501,981	....	25,032,017
California	850,506	1,146,092	....	1,996,598
Colorado	24.293.297	539.947	111,082	24,722,162
Idaho:				
Sections 1-5	7,193,220	1,289,074	27,189	8,455,105
Section 6	53,316	33,598	121	86,793
	7,246,536	1,322,672	27,310	8.541,898
Kansas	....	277,605	....	277,605
Montana	42,997,071	3,766,349	2,607	46,760.813
Nevada	46,303,933	1,264	....	46,305,197
New Mexico	19,045,996	4,328,545	....	23,374,541
North Dakota	8,379,764	360,057	314	8,739,507
Oregon	14,869,825	2,066,723	....	16.936,548
South Dakota	....	1,756,332	....	1.756,332
Utah:				
Sections 1-5	6,966,309	181,244	160	7,147,393
Section 6	1,217,106	2,606	680	1,219,032
	8,183.415	183.850	840	8,366,425
Washington	3,660,853	384,688	28,654	4,016,887
Wyoming	17,920.496	849,154	....	18,796,650
	218,281,728	17,485,259	170,807	235,596,180

The general provisions of the acts, which apply in all 14 States, permit the entry by one person of 320 acres of "nonmineral, nonirrigable, unreserved, and unappropriated surveyed public lands which do not contain merchantable timber." As a prerequisite to the allowance of such entry, the land must have been designated by the Secretary of the Interior as not being, in his opinion, "susceptible of successful irrigation at a reasonable cost from any known source of water supply." Under the provisions of section 6 of the acts of February 19, 1909, and June 17, 1910, applicable in Utah and Idaho, the Secretary may further designate lands which do not have upon them "such a sufficient supply of water suitable for domestic purposes as would make continuous residence upon the lands possible," and entrymen upon such lands are relieved of the necessity of residence. By the act of March 3, 1915 (38 Stat., 956), the enlarged homestead act was amended so as to permit, under certain conditions, an additional entry, though final proof has already been submitted on the original entry.

Designations under the enlarged-homestead act are made either in large, compact areas, as a result of field investigations covering rather large districts, or in small units, as a result of investigations made at the request of prospective entrymen. These requests are referred to as enlarged homestead petitions, and because of the fact that the larger areas of land to which the acts are believed to be applicable have already been designated, the record of the year shows a large increase in the number of petitions received. This has in part been the result of the extension of enlarged homesteads to two additional States and in part of the passage of the act of March 4, 1915 (38 Stat., 1163), which provides that a preference right to enter the lands designated can be secured by the filing of an application at the local land office of the district in which the lands are situated. The following table indicates the disposition made of petitions received during the year:

Action on petitions under the enlarged-homestead acts during the fiscal year 1915.

State.	Pending July 1, 1914.	Received during fiscal year.	Action taken.			Total acted on.	Pending June 30, 1915.	Cases reconsidered.
			All designated.	Part designated.	Refused.			
Arizona	8	51	37	2	7	46	13	3
California	66	333	210	0	27	237	162	10
Colorado	54	257	106	12	51	169	142	17
Idaho	481	826	473	45	397	915	392	122
Kansas	0	194	63	1	1	65	129	0
Montana	619	1,803	1,061	124	162	1,347	1,075	81
Nevada	0	12	3	0	0	3	9	0
New Mexico	42	293	174	35	38	247	88	23
North Dakota	67	111	131	7	17	155	23	46
Oregon	136	336	327	40	41	408	64	35
South Dakota	0	905	52	1	1	54	851	0
Utah	79	197	41	3	18	62	214	3
Washington	39	127	104	7	7	118	48	2
Wyoming	66	221	126	26	18	170	117	30
	1,657	5,666	2,908	303	785	3,996	3,327	372

A set of maps of the States affected, showing areas designated under the enlarged-homestead acts and the status of designations June 30, 1915, has been printed.

PUBLIC WATER RESERVES.

As information has become available recommendations have continued to be made for the creation of public water reserves, in order that important springs and sources of stock water on the desert and semiarid range lands may remain accessible to the public. Additions amounting to 19,257 acres have been made during the year to reserves of this type. The action taken is summarized in the following table:

Public water reserves withdrawn from entry and restored to entry during the fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	Withdrawn during fiscal year.	Restored to entry during fiscal year.	Outstanding June 30, 1915.
Arizona	1,200	1,918	126	2,992
California	43,524	7,030		50,554
Colorado	480			480
Idaho		5,765		5,765
Montana		1,040		1,040
Nevada		1,464		1,464
New Mexico	1,440			1,440
Oregon	2,500			2,500
Utah	32,707	1,520	240	33,987
Wyoming	81,911	520		82,431
	163,762	19,257	366	182,653

PUBLICATION BRANCH.

DIVISION OF BOOK PUBLICATION.

SECTION OF TEXTS.

During the year 48,911 pages of manuscript were edited and prepared for printing and proof sheets for 21,407 final printed pages were read and corrected. This work involved the handling of 5,099 galley proofs and 35,522 page proofs. The corresponding figures for 1913–14 were 47,751 pages of manuscript, 16,786 final printed pages, 4,574 galley proofs, and 28,202 page proofs. Indexes were prepared for 66 publications, covering 16,723 pages; the figures for the previous year were 56 publications and 11,143 pages. The list given on pages 16–37 shows the number, scope, and character of the reports issued during the year.

At the close of the fiscal year eight persons were employed in this section. The water-resources branch has continued to render special assistance in copy preparing and proof reading.

SECTION OF ILLUSTRATIONS.

The number of illustrations prepared was 3,553, comprising 191 maps, 765 photographs prepared for reproduction, 905 diagrams and sections, 1,480 paleontologic drawings and photographs, and 212 miscellaneous. The processes used for the reproduction of the illustrations sent to the printer and the number reproduced by each process were as follows: Chromolithography and photolithography, 185 subjects; halftone engraving, 674 subjects; zinc etching, 553 subjects; wax engraving, 1 subject; cuts already engraved, 74 subjects. Proofs to the number of 2,000, including 380 revises, were received and compared critically. The finished work representing all the lithographs furnished by contractors was examined. Electrotypes of 99 cuts were furnished to outside applicants. At the close of the year material for illustrating 24 reports was in preparation.

As in previous years, a cost record has been maintained. The personnel of the section at the close of the year consists of the chief of the section, 9 draftsmen, 1 under clerk, and 1 messenger boy.

SECTION OF DISTRIBUTION.

The section of distribution received during the year 187 new books, 16 reprinted books, 3 new geologic folios, 17 geologic maps, 3 revised and reprinted geologic folios, 8 revised geologic maps, 4 reprints of geologic maps, 90 new topographic maps, 9 revised maps, 8 photolithographs, and 98 reprints of maps, a total of 443 publications. The total of all editions received was 689,192 books, 24,066 geologic folios, and 711,711 maps, a grand total of 1,424,969. This does not include pamphlets for administrative use, such as lists of publications and index maps.

There were distributed 596,649 books, 23,588 folios, and 487,049 maps, including 136 books, 16,583 folios, and 342,404 maps sold, a total of 1,107,286, an increase in books and maps and a decrease in folios, the demand originating from the low-priced sale of folios because of fire damage being largely satisfied last year.

The total amount received and turned into the Treasury as the result of sales of publications was $27,711.12. The sales of topographic and geologic maps amounted to $26,030.97, of topographic and geologic folios $1,400.15, and of books $280.

Sixteen persons were employed in this section during the year, and 84,788 letters were received and answered during that period.

DIVISION OF MAP EDITING.

SECTION OF GEOLOGIC MAPS.

This section continued in charge of George W. Stose, geologist, who directed the publication of the maps and illustrations of the geologic folios and critically reviewed all geologic maps intended for publication in other reports of the Survey.

Twenty-seven folios were handled in the section during the year. Six folios were completed and published during the year—Nos. 193 to 195, inclusive, and reprints of Nos. 112, 148, and 155, which were out of stock and were revised and brought up to date. The three new folios are noticed in the list of publications on page 36.

At the close of the fiscal year the maps and illustrations of folios 196 (Philipsburg, Mont.), 197 (Columbus, Ohio), and 198 (Castle Rock, Colo.) were complete and their texts were in proof, so that these three folios will be issued soon. The maps and structure sections of folios 199 (Silver City, N. Mex.), 200 (Galena-Elizabeth, Ill.), and 202 (Eureka Springs-Harrison, Ark.) were also printed, and the other illustrations of these folios were near completion. The maps and sections of the Colorado Springs (Colo.) folio were in press, the maps of the Leavenworth-Smithville (Mo.-Kans.) folio were in stone proof, and the maps of folio 201 (Minneapolis-St. Paul, Minn.) were engraved and in part in stone proof. The engraving of the maps for the Deming (N. Mex.), Detroit (Mich.), and Tolchester (Md.) folios was begun. The Colchester-Macomb (Ill.), Elkton-Wilmington (Md.-Del.), and Herman-Morris (Minn.) maps have been prepared for engraving, which will be begun as soon as the texts are completely criticized and revised. The Cleveland (Ohio), Pittsfield-Becket (Mass.), and Sheffield-Sandisfield (Mass.) maps have been partly prepared for engraving, but are awaiting slight field inspection. The Bellefonte (Pa.), Bessemer-Vandiver (Ala.), and Montevallo-Columbiana (Ala.) maps have been examined, but are awaiting field conference and office revision before preparation for engraving.

Two draftsmen, specially qualified to read and prepare geologic maps, sections, and other drawings, are employed in the section under the direction of the geologist in charge.

SECTION OF TOPOGRAPHIC MAPS.

At the beginning of the year 183 atlas sheets and maps of special areas were on hand for publication and the accessions during the year were 102, making a total of 285. Of these, 107 (90 new engraved maps, 9 engraved maps which are new editions or new in form of publication, and 8 photolithographs) were published. The following statement shows the comparative status of map editing and publication on June 30 for the last five years:

Progress of map publication for five years ended June 30, 1915.

	1911	1912	1913	1914	1915
Published during the year	86	114	101	102	107
In process of engraving	56	65	89	69	87
Unedited	95	102	105	114	91

The manuscripts edited during the year comprise 117 topographic atlas sheets and other maps prepared for engraving, 3 of which were afterward withdrawn from publication, 26 sheets of plans and profiles of 11 rivers, corrections for 128 engraved maps about to be reprinted, and 226 maps or sheets for the illustration of 33 Survey reports. The proof read comprises 98 new topographic maps, corrections to 57 old maps, 2 panoramic views, and 15 maps reproduced under contract. The index maps for 11 circulars of the series 9–323 were revised and reprinted during the year, and a text was adapted for each of 14 new State index circulars which have been published.

Six men were continuously employed in this work.

DIVISION OF ENGRAVING AND PRINTING.

MAPS AND FOLIOS.

During the fiscal year 90 topographic maps were engraved and printed; 9 topographic atlas sheets were corrected after field revision and new editions printed; and 7 State maps, scale 1:500,000, and 1 three-color topographic map were photolithographed and printed during the year, making the total number of new maps and new editions printed 107.

Corrections were engraved on the plates of 118 sheets, including 112 for reprinted editions and 6 for other purposes. Of those corrected for reprinting, including new maps (engraved and photolithographed), 206 different editions were printed and delivered to the map room. This is a decrease of 95 editions and 232,011 copies of regular office maps from the previous year.

Three new geologic folios and three reprinted folios were published during the year, the number published in the preceding year. Of the new folios one is a double folio and one (the San Francisco) contains five sets of geologic maps. State editions of two folios and octavo editions of two folios were issued during the year. Editions and partial editions of folios and octavos amounting to 24,066 copies were printed and delivered, a decrease of 4,164 copies during the year.

CONTRACT ENGRAVING AND PRINTING.

For the Government Printing Office the following items were printed and delivered: Illustrations for the annual report of the governor of Hawaii; annual report of the Commissioner General of Immigration; annual report of the Commissioner of Indian Affairs; annual report of the Chief of Engineers, United States Army; annual report of the governor of Alaska; annual report of the Board of Regents, Smithsonian Institution; annual reports of the War Department, volume 2 (War Document 480); Fiscal regulations, Department of Agriculture, 1915; Limnological study of the Finger

Lakes of New York, Bureau of Fisheries; American Ephemeris and Nautical Almanac, 1915; American Ephemeris and Nautical Almanac, 1918; Report on education of the natives of Alaska; Statistical Atlas of the United States, 1910; Department of Agriculture Bulletins 181, 198, and 204; Census reports, volumes 1–3, population, volume 5 (agriculture, general report and analysis); Department of Agriculture, Office of the Secretary, Report 100, Potash from kelp; Plane-table manual (Appendix 7, report of the Superintendent of the Coast and Geodetic Survey, 1905); United States Coast Pilot, part 4, Point Judith to New York; Inside Route Pilot, Key West to New Orleans; Inside Route Pilot, coast of New Jersey; Revenue-Cutter Service Bulletin 3, International ice observation and ice patrol in the north Atlantic Ocean; Bureau of Mines Bulletin 98, report of the Selby Smelter Commission; Interstate Commerce Commission reports, volume 24; House Document 971, Sixty-third Congress, second session—Red Lake Reservation; illustrations for Geological Survey Bulletins 527, 531–B, 575, 576, 578, 580–K, 580–M, 581–D, 582, 586, 589, 590, 592, 592–A, 596, 600, 602, 604, 606, Professional Papers 87, 90–I, 90–J, 95–B, Water-Supply Papers 306, 309, 319, 338, 342, 343, 344, 346, 347, 348, 349, 350, 366, 367, 368, 369, Mineral Resources, The stone industry in 1912, The stone industry in 1915, and Topographic instructions of the Geological Survey. In addition, the following separate illustrations were printed and delivered to the Government Printing Office: Diagrams of six bird reservations and one elk reservation; panoramic views of Yosemite, Yellowstone, Glacier, Mount Rainier, and Crater Lake national parks; maps showing glaciers of Glacier and Mount Rainier national parks; map showing origin of the scenic features of Glacier National Park; Photometric lamp-sheet test, Form 174; township blank, Form 4–675a; map of National Zoological Park; map of the United States by counties; map of the world (Department of Agriculture); map showing the areas quarantined for the gypsy moth and brown-tail moth, 1914 (Department of Agriculture); Protractor, Form 678 (Department of the Interior); sectional diagram (Department of the Interior); identification cards (Department of the Interior); sample markings for brass caps (Department of the Interior).

The following work was done for other Government departments and bureaus: For the Forest Service, maps of 17 national forests, 11 fire folders and tourists maps, 5 proclamation diagrams of national forests, 4 enlargements of field sheets, annual programs of work, 1914 and 1915, annual estimate blank, blank form (grazing classification), diagram, Form 493, homestead entry plats, lookout station protractor, map showing national forest areas, map of North America 7½ by 10 inches, map of North America 15 by 20 inches, North America outline map, map of southern Appalachian region, United

States contour map, section diagrams, and other miscellaneous work; for the General Land Office, 1,492 township plats, 677 mineral plats, 12 State maps showing homesteads, maps of two Indian reservations, 21 plats of villa sites, and other miscellaneous works; for the Office of Indian Affairs, maps of 4 Indian reservations; for the Panama Canal, 10 maps of Canal Zone and 1 map showing Isthmus and completed canal. Work was also done for the Reclamation Service, Alaska Boundary Survey, War Department (Corps of Engineers, United States Army), Interstate Commerce Commission, District of Columbia (public schools), War Department (Students' Military Instruction Camp), Panama-Pacific International Exposition, Bureau of Mines, Bureau of Standards, Bureau of Education, Weather Bureau, Public Health Service, Department of the Interior, Smithsonian Institution, Alaskan Engineering Commission, Bureau of Lighthouses, Department of Labor, Department of Agriculture (Bureau of Chemistry), War Department (Army Service Schools and Coast Artillery School), Department of Labor (Immigration Service), Navy Department (United States Marine Corps), Bureau of Labor Statistics, Hydrographic Office, Bureau of American Ethnology, National Museum, Post Office Department, Bureau of Soils, and United States and Canada Boundary Survey. In addition to the above, a large amount of miscellaneous work was done for other divisions and branches of the Survey. This work for various branches of the Government amounted to about $72,000, for which the division was reimbursed by transfer of credit on the books of the United States Treasury.

Work was also done for Houghton, Mifflin & Co., Heliotype Co. of Boston, Norris Peters Co., Geological Survey of New Jersey, J. M. Kennedy, Department of Chemical Engineering, University of Michigan, War Department (United States Engineers Office, Philadelphia, Pa.), and N. C. Grover, and the money received in payment for the work, amounting to about $350, was turned into the Treasury of the United States to be credited to miscellaneous receipts. Under cooperative agreements, transfer impressions were furnished without charge to the State surveys of Kentucky, Illinois, and Pennsylvania.

There was also a large amount of miscellaneous office work, including index circulars, list of geologic folios and topographic maps, State maps, etc. This work, for which no refund was obtained, amounted to about $4,500.

Of contract and miscellaneous printing of all kinds, the total number of copies delivered was 2,803,428, which required approximately 3,850,004 printings. The total number of copies printed, including topographic maps and geologic folios, was 3,533,726, requiring approximately 8,525,104 impressions. On requisition of the Government Printing Office, 333 transfer impressions were made and shipped by contracting printers.

PHOTOGRAPHIC LABORATORY.

The output of the photographic laboratory included 15,095 negatives, of which 2,378 were dry, 3,652 were wet, 664 were paper, 7,437 were field negatives developed, 964 were lantern slides, and 2,361 were photolithographic; 3,824 zinc plates, 278 zinc etchings, 248 celluloids, and 48,734 prints, of which 22,906 were maps and diagrams and 25,828 were photographs for illustrations. In addition 2,110 prints were mounted and 192 slides colored.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

The work in the executive division was of the usual scope except that the work of the stores section and the shipping and receiving clerk was transferred to the division of accounts.

Mails, files, and records.—During the year 138,791 pieces of mail, of which 2,443 were registered, were opened and referred. In addition, 90,395 letters were received direct by the other divisions, a total of 229,186 for the Survey.

Of the letters opened in this division, 24,037 contained a total of $28,521.80 remitted for Survey publications, a decrease of 1 per cent in number of letters, and $1,283.93 in amount, compared with the fiscal year 1914.

The recording, referring, filing, and mailing of correspondence required practically the entire services of seven clerks. The number of letters mailed through the division was 136,827, an increase of about 13 per cent over the preceding year. This number does not include the outgoing registered mail, which numbered 11,960 pieces, or 239,559 pieces of letter mail sent direct from the other divisions—a total of 388,346 for the Survey, an increase of 6 per cent over 1914.

Personnel.—The roll of Secretary's appointees numbered 909 at the close of the fiscal year, 18 more than at the close of the fiscal year 1914. The total number of changes in the personnel for the year was 586, which included 131 new appointments, 112 separations, 305 promotions, 2 reductions, and 36 miscellaneous changes.

During the year 15,037 days of annual leave and 2,771 days of sick leave were granted, being 66 per cent of the amount of annual leave and 12 per cent of the amount of sick leave which it is permissible to grant under the law; 5,288 days of leave without pay were also granted.

DIVISION OF ACCOUNTS.

During the year the handling of express and freight shipments and issuing of stationery supplies from stock was transferred from the executive division to the division of accounts. During the year 3,504 pieces of freight and express were handled, of which 970 were outgoing and 2,534 were incoming, and 6,338 requisitions were filled from stock in the stationery room.

A condensed statement covering the financial transactions during the fiscal year is given below, including disbursements up to September 30. The unexpended balances of that date largely represent outstanding obligations.

Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1915.

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of Director	$35,340.00	....	$35,340.00	$35,198.83	$141.17
Salaries, scientific assistants	29,900.00	....	29,900.00	29,800.00	100.00
Skilled laborers, etc	20,000.00	....	20,000.00	19,999.66	.34
Gaging streams, etc	150,000.00	$33,634.72	183,634.72	182,750.14	884.58
Chemical and physical researches	40,000.00	12.04	40,012.04	38,487.77	1,524.27
Preparation of illustrations	18,280.00	....	18,280.00	18,200.41	79.59
Mineral resources of United States	75,000.00	43.33	75,043.33	74,792.50	250.83
Geologic maps of United States	110,000.00	73,325.61	183,325.61	160,959.53	22,366.08
Books for the library	2,000.00	....	2,000.00	1,326.25	673.75
Topographic surveys	350,000.00	1,134.72	351,134.72	349,653.86	1,480.86
Geologic surveys	400,000.00	3,018.37	403,018.37	388,413.39	14,604.98
Mineral resources of Alaska	100,000.00	.77	100,000.77	94,586.45	5,414.32
Surveying national forests	75,000.00	3.57	75,003.57	73,866.19	1,137.38
	1,405,520.00	111,173.13	1,516,693.13	1,468,034.98	48,658.15

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30,

Appropriation.	Total.	Salaries and wages.	Transportation of persons.	Transportation of things.	Subsistence and support of persons.	Subsistence and care of animals.	Communication service.	Printing, engraving, lithographing, etc.	Furnishing heat, light, power, etc.	Special and miscellaneous service.	Materials.	Stationery, drafting, etc., supplies.
Salaries, office of the Director	$35,198.83	$35,198.83										
Salaries, scientific assistants	29,800.00	29,800.00										
Skilled laborers, etc	19,999.66	19,999.66										
Gaging streams, etc	182,750.14	135,892.45	$17,571.34	$1,136.39	$9,926.37	$507.48	$898.61	$1,857.22	$4.20	$1,092.89	$1,527.66	$1,902.33
Chemical and physical researches	38,487.77	25,659.12	1,380.07	1,570.77	802.75	27.29	95.61	8.52	371.13	171.71	1,237.91	697.07
Preparation of illustrations	18,200.41	16,973.17		1.49			19.49	972.47		1.78	3.27	189.92
Mineral resources United States	74,792.50	67,983.71	1,704.55	76.98	1,118.03	.33	627.07	689.08		291.40	1.31	953.12
Geologic maps	160,959.53	130,519.99	122.90	58.22	77.40		66.23	1,450.39	2,131.28	2,072.59	4,524.41	15,554.22
Books for the library	1,326.25			4.10			.95					
Topographic surveys	349,653.86	238,285.20	27,921.78	3,735.75	41,743.63	9,936.41	835.36	3,793.26		2,145.34	1,267.23	2,068.52
Geologic surveys	388,413.39	304,081.61	27,623.47	2,221.29	20,233.29	4,937.20	1,191.70	6,204.24	12.35	4,509.70	446.71	2,672.62
Mineral resources of Alaska	94,586.45	61,161.12	14,069.96	2,627.80	4,174.42	404.60	180.85	1,255.30		593.51	235.82	763.79
Surveying national forests	73,866.19	48,178.69	4,052.65	543.90	7,673.66	5,068.84	135.58	146.20		762.25	267.76	445.73
	1,468,034.98	1,113,733.55	94,446.72	11,976,69	85,749.55	20,882.15	4,051.45	16,376.68	2,518.96	12,241.17	9,512.08	25,247.32

Appropriation.	Fuel.	Mechanic's, engineer's, etc., supplies.	Cleaning and toilet supplies.	Wearing apparel.	Forage and other supplies for animals.	Provisions.	Ammunition and explosives.	Special and miscellaneous supplies.	Equipment (including live stock).	Structures (bench marks).	Rent.
Gaging streams, etc	$142.63	$381.14	$2.65	$35.50	$134.21	$172.73	$4.55	$97.92	$6,121.42	$332.00	$2,408.45
Chemical and physical researches	325.27	87.31	19.97	2.05	145.33	847.92		30.73	4,820.04		187.20
Preparation of illustrations									38.82		
Mineral resources United States		.72	10.80						978.10		357.30
Geologic maps	95.61	558.92	276.64			18.95	7.72		3,424.06		
Books for the library									1,321.20		
Topographic surveys	284.10	44.77	37.19	1.34	4,726.36	3,195.06		72.08	7,345.73	2,131.10	83.65
Geologic surveys	177.86	69.34	40.72	14.00	1,407.45	4,140.36	155.84	242.86	7,993.28		37.50
Mineral resources of Alaska	180.91	12.51	54.81	88.65	1,361.47	2,907.07	58.72	77.73	4,292.73		84.68
Surveying national forests	72.36	7.38	56.37	1.02	2,701.59	1,784.97		10.30	1,894.25	59.68	3.01
	1,278.74	1,162.09	499.15	142.56	10,476.41	13,067.06	226.83	531.62	38,229.63	2,522.78	3,161.79

LIBRARY.

The library has acquired during the year all the important new publications of geologic interest or bearing on the work of the Survey. The European exchanges were somewhat less numerous than usual on account of the war. Altogether 12,795 books, pamphlets, and periodicals and 1,218 maps were received.

The cataloguing included current accessions and also the final cataloguing of older sections of the collection, embracing the geological surveys of Finland, Greenland, India, Mysore Province, Netherlands, Prussia, Rumania, the Transvaal, and the Union of South Africa; 60 sets of periodicals; and monographs on chemistry and on general, dynamic, structural, historical, and economic geology. The library furnished 777 title entries to the Library of Congress for printing; 11,968 cards were added to the catalogue.

Recorded loans numbered 8,069 books and 272 maps, this number not including the books and maps used in the library by 9,022 readers. The classification scheme and the catalogue have served as guides for the librarians of a number of geologic libraries, who have visited the Survey library and studied its working methods.

During the last nine months of the year about 600 books from the Washington City Public Library have been deposited in this library for recreative and educational reading by members of the Survey. From this deposit 1,713 loans were made, of which about 12 per cent were books on biography, poetry, travel, and the social sciences.

The bibliography of North American geology for 1913 was published as Bulletin 584. The bibliography for 1914 has been completed and is passing through the press as Bulletin 617. Work has continued throughout the year on the bibliography and index comprising all the published literature of American geology.

Exchange copies of Survey publications have been distributed promptly both to domestic and foreign libraries, with the exception of those for libraries in the countries now at war. These have been necessarily withheld until the Smithsonian International Exchange shipments shall be resumed.

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DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

THIRTY-SEVENTH ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30
1916

WASHINGTON
GOVERNMENT PRINTING OFFICE
1916

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THIRTY-SEVENTH ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

GEORGE OTIS SMITH, *Director*.

The appropriations for the work of the United States Geological Survey for the fiscal year 1915–16 comprised items amounting to $1,570,520. The plan of operations was approved by the Secretary of the Interior, and detailed statements of the work performed are given in this report.

SPECIAL FEATURES.

ECONOMY IN SCIENCE.

The increased extent to which the large industrial corporations of the country now support their own departments of scientific research is a gratifying development of the times. Science is regarded as a necessity rather than a luxury. And this coming of science into its own as a large factor in the industrial life of the Nation is necessarily followed by a certain reaction of business upon science. Never before, perhaps, has the demand been so keen for research that is no less than ever scientific in spirit and in method but that has a definite purpose and yields definite results. The idea of making science useful is not new, but the utility of science has become more universally the test of its value.

In the scientific work done under the Federal Government this demand for results is abundantly justified by the public need. If the strongest corporations are making large use of chemists, physicists, and geologists, the general public has similar need in its service for applied science.

The business policy of organizing scientific investigation for effective work, however, is far from novel, for in 1878, in the report to Congress advocating the creation of the United States Geological Survey, the National Academy of Sciences described the ideal plan for a scientific bureau as that which would yield the "best results at the least possible cost." Since that day, moreover, economy in science has become a more pressing issue.

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At the centennial exercises of the United States Coast and Geodetic Survey, in April, 1916, the Director of the Geological Survey called attention to the gratifying fact that for nearly four decades the two Surveys had worked side by side in the cause of American science coordinately rather than competitively. The result has been economy instead of waste. With this record in mind the appeal was then made for the application to the business of the two score Federal scientific bureaus of the same rules that the legislatures and courts now enforce for the control of corporations. Unrestrained competition in the public service is no less wasteful than unregulated competition in private business. The ideal of the best service at the lowest cost leads to the recognition of the idea of natural monopolies in the Government scientific service, for this recognition will insure the same real saving to society that has come with the recent growth of public-utility monopolies. It does not follow that because the scientific bureau offers a special service to the public without direct price the public official is any less vitally interested in actual costs.

If the scientific work of the Government is to be organized on the basis of specialization rather than of competition the correlative idea of adequate regulation must be adopted. A large share of this duty of insuring a proper coordination of the public scientific work must be accepted directly by the bureau chiefs and their immediate advisers in the work of administration. Moreover, to this group of Government scientists the obligation is double—they are constrained as public servants to avoid wasteful use of public money and as scientists to conserve scientific effort by preventing duplication in research and in publication. Faith in the effectiveness of highly specialized science must carry with it the belief that some one bureau, by reason of its organization, personnel, and experience, can conduct scientific investigations of a certain kind better than any other bureau. This is practical logic of the type that is recognized in private business, for under the public regulation of natural monopoly the public-utility company that first enters the local field is recognized and even protected by the public-service commission as long as the service it renders is at all adequate. The attempt of an overzealous bureau chief to seek preferment for his bureau on other grounds is not in harmony with the public-service idea that the Federal scientific bureau is only an agency to get results that are of largest value to the public it serves.

STATISTICS THAT HAVE VALUE AS NEWS.

A leading trade journal in a recent editorial commented upon the United States Geological Survey's "enviable reputation for accuracy and preciseness throughout all its different branches" but added that in maintaining this accuracy the Survey had "in the past shown a tendency to ignore the necessity for promptness in placing its vast store of statistical data before the public." This editorial, which was headed "Geological Survey speeding up on statistics," was prompted by the innovation in publishing statistics of coal production referred to below.

The obvious difficulty of giving to the public statistical data that are accurate and yet not somewhat out of date has been met since 1910 by supplementing the complete detailed reports with the publication in the first week of January of preliminary estimates of mineral production for the year just ended. These new-year statements have now attained a degree of accuracy that not only meets the practical needs of most users of this information but also robs the later complete reports of their news value. Thus the Survey's estimate of the gold output of Alaska for 1915, published January 1, 1916, was less than 1.2 per cent in excess of the final figures made public about four months later, and Alaska's exceptionally large yield of copper was estimated within 3 per cent. For the last two years the preliminary estimates of the coal output of the United States were only four-tenths of 1 per cent and 2.6 per cent in error; for the more erratic petroleum industry the estimates of marketed output published January 1 have been within one-half of 1 per cent and 5 per cent of the final figures; the preliminary estimates of cement were within three-tenths of 1 per cent and four-tenths of 1 per cent of the actual output. The Survey geologist who made an estimate of the output of iron ore for 1914, in a statement issued January 1, 1915, "approximated" the final figures with an error of only 239 tons, and his preliminary figures for the output in 1915, published January 1, 1916, were within nine-tenths of 1 per cent of the complete final figures.

It is, of course, through the collection of detailed statistics from individual producers that the specialist is able to keep so closely in touch with his subject that his preliminary estimates have high value for approximate accuracy. Some advances have been made in the date of publication of the final statistical reports, but here the compiler encounters the difficulty of obtaining full and prompt cooperation from a very small minority of the producers, so that it is the last 1 or 2 per cent of the returns that cost the most time and effort. A gain of weeks in the date of publication of the statistics of some products might be made, but only at a sacrifice in the quality of the results. The standard of accuracy maintained by the man of scientific training shows itself in his aversion to round figures. The Survey will continue to seek improvement in the promptness of issue of the final reports, but the public need for authoritative mineral statistics possessing full news value will be met by estimates published January 1 and at other times in the year. The Survey's new-year and mid-year statements have already won a place in the public press because they furnish the business interests with impartial estimates of the rate of production of the raw materials and fuels that are so essential to the Nation's industry and commerce.

As information to be valuable must be timely, the Geological Survey regards the preparation and issue of its quarterly and monthly statements as representing the ideal plan for statistics of all the principal metals and mineral fuels. Already a further step in the same direction has been planned: commencing August 15, the Survey will issue every month a comparative statement of railroad movement of coal and coke for the preceding month. It is believed that these authoritative figures will furnish the public a valuable index of the general industrial conditions as well as of the current rate of utilization of the country's mineral reserves.

THE GEOLOGY OF PETROLEUM.

The far-reaching importance to the United States of an adequate supply of petroleum and gasoline has long been recognized by the Survey, which during the last two years has made greater efforts than ever before to assist in discovering and in developing new oil reserves. Brief accounts of the work accomplished, with titles of reports published or in preparation this year, describing the structure and oil prospects in many new and undeveloped areas, especially in the Western States, in the Southwest, and in the Midcontinent region, will be found in the record of the geologic work carried on in the several States (pp. 51–91). Even with all the funds which, with justice to other mineral interests, could be devoted to investigations of oil and gas, it has not been found possible to extend these researches at all in proportion to the increase in public demand for information both as to old and to new fields. A recent editorial in the Standard Oil Bulletin states: "Time was when oil operators were strongly inclined to give little or no heed to the opinions of geologists, but that time is past." The value of the studies of geologic structure in the search for oil is not only thus recognized by the great oil companies, but most of these corporations are now recruiting corps of geologists, if they had not already had trained geologists in their employ. Naturally, the information thus acquired by these corporations for their guidance in leasing lands and in locating exploratory drill holes is not available to the public—a fact which makes more pressing the need of the landowner and of the small independent driller for all the information which the Federal or State surveys can give.

One function that is especially appropriate for the national service is the prosecution of field studies seeking a better understanding of the principles and conditions governing the origin, movement, and segregation of oil and gas, thus extending direct aid in the discovery of new pools and new fields. With this object in view, attention is given not only to the geologic structure in the pools already developed and to the mutual relations of the oil, gas, and water as revealed by the drill, but to the problems of discontinuity, tightness, cementation by chemical reaction, porosity, and the more difficult questions of capillarity. In the investigations of such subjects, concerning which some misinformation seems to exist, the physicists of the division of chemistry and physics are cooperating with the geologists.

Estimates of the reserves of petroleum remaining in the ground in the different States were compiled in February by the Survey geologists for the use of the Secretary of the Interior in reply (Senate Doc. 310) to Senate resolution No. 40, Sixty-fourth Congress. Further, in anticipation of the day when, on account of the advancing cost of gasoline and other products obtained from petroleum, it might be found commercially profitable to utilize some of the enormous supply of petroleum to be derived from the distillation of the vast deposits of so-called hydrocarbon shales of the Green River formation of northwestern Colorado and northeastern Utah, the Survey has for three years been making field investigations of these deposits. The examinations have been accompanied by mapping of the areas of hydrocarbon shales and by such field measurements of the thickness of the shales in workable beds and such rude field distillation tests as will afford primary information concerning the amount and richness of the shales in different parts of the region.

Very rough but cautious calculations of the contents of the shale in parts of the area examined indicate that the distillation of shale from beds over 3 feet thick in Colorado alone will yield more than 20,000,000,000 barrels of crude oil, from which more than 2,000,000,000 barrels of gasoline can be extracted by ordinary methods. A report giving the results of these explorations and tests and an account of experiments as to possible gasoline production, both by the ordinary commercial processes and by the Rittman process, is now in press.

THE SEARCH FOR POTASH.

The search for potash has continued with unabated zeal. The project of drilling in Smoke Creek Desert, Nev., outlined in last year's annual report, was completed, four deep wells having been put down at selected points in that locality. No potash of commercial importance was found. However, the fact has from the first been clearly recognized that the chances of success in this search must necessarily be small at most places, for the area in the western

United States to be explored is large and the funds available for tests by deep drilling must limit these tests to a few places each year. The surface indications that may help in determining places for drilling are only of the most general nature, yet these have been utilized with skill and judgment in the location of the tests made, and it is not questioned that the possibilities fully justified those tests.

In view of the character of the deposits encountered in the tests of the Quaternary lake beds of the Great Basin region it was concluded that probably there were better prospects of discovering deposits of potash and other salts in the Permo-Triassic "Red Beds" of the Southwest and of the Rocky Mountain region. The field examinations of the "Red Beds," to which reference was made in the last report, clearly indicated the occurrence of several periods of dry climate while this series of beds was being laid down, with consequent evaporation of continental water bodies, and these field studies have also disclosed interesting evidence of the deposition by evaporation of enormous deposits of rock salt, gypsum, and anhydrite in parts of the "Red Beds" country, especially in eastern New Mexico, northwestern Texas, and western Oklahoma.

Most of the drilling for water or for oil in this region has been confined to a few localities, so that in large areas the drill has never penetrated the deeper strata and the interbedded saline deposits. However, the drilling already done shows the presence of as much as 600 or 700 feet of buried rock salt in parts of the great "Red Beds" region. Potash, if present in stratified precipitate, should be associated with some of these saline deposits. Furthermore, the strata of this region, which consist largely of red sandstones and shales, thin dolomites, and gypsum, are similar in composition and general character to those that contain the great potash deposits of Germany, where also large deposits of gypsum and rock salt lie between the rock beds. It should also be noted that the periods of aridity and of saline deposition in the southwestern part of this country were essentially contemporaneous with the periods of evaporation and precipitation in the Stassfurt district. Finally, crystals of potash salts were found in the waste from a bore hole near Boden, not far from Amarillo, Tex., by Dr. J. A. Udden, of the Bureau of Economic Geology and Technology of the University of Texas, and he also found traces of potash in muds or brines from several other wells, the earliest discovery—that in the brines of the well at Spurr, in Dickens County—having been made by Dr. Udden while he was examining drill samples and studying drill logs from western Texas under the auspices of the Federal Survey.

The facts cited justify the hope that beds of potash salts, possibly of commercial importance, may lie buried somewhere in the great "Red Beds" region of the Southwest. Such deposits were perhaps precipitated only in very small areas in much reduced remnants of the shallow seas of the period. If they exist, they are likely to be lenticular, and, though their areal extent is problematic, they are doubtless of very slight extent in comparison with the great area of the "Red Beds." It therefore follows that if lenses of commercial importance exist in these beds a large number of holes may be drilled in different areas, even under the best geologic guidance, before such a lens is penetrated by the drill. On the other hand, it is possible that drillers may already have penetrated such lenses in their search for oil or water without recognizing the fact, for generally no analyses of the "brines" or the "salt beds" so encountered are made by owners or drillers. At the present rate of the Geological Survey's drilling tests in this region, it must be expected that many years may pass before the drill shall penetrate a single lens. Nevertheless, the need of getting adequate supplies of cheap potash in this country—and none are likely to be so cheap or so adequate as those that lie buried in the earth—is obviously so great and so imperative as to leave little doubt of the wisdom or, possibly, the necessity of incurring the expense of discovering them or proving that they do not exist.

There are indications that a great basin of salt water was evaporated in the Panhandle region of northern Texas, and as potash-bearing crystals of salt were found near Boden, and traces of potash are said to have been found in brines or muds from wells at two or three other localities in this general region, a place at Cliffside, 7 miles northwest of Amarillo, was chosen for the first test to be made by the Survey in the "Red Beds" country. Accordingly, after the tests in the Smoke Creek Desert, Nev., were completed, the drill was shipped to Cliffside, where the owners of certain lands generously permitted the Survey to use them for like tests under terms of option by the Government. Work was begun in the autumn, and, in spite of such accidents as are usually incidental to boring in the "Red Beds," the hole was carried to a depth of 361 feet before the balance of the funds available for potash exploration was exhausted.

It is hoped that with the funds provided in the appropriation for the fiscal year 1917 it will be possible to continue this well to a depth of at least 1,800 feet, which should be sufficient to determine the stratigraphic position and the character of the deposits that furnish the red potash-salt crystals near Boden, if not to carry it to the base of the lowest salt bed, which is probably at a depth of nearly 2,300 feet. This drill hole, which should afford a thorough test of the questions raised by the indications found near Boden, will, however, be conclusive only for this area and, if unsuccessful, can not be regarded as condemning other areas in the "Red Beds" region.

Meanwhile, efforts are being made to enlist the cooperation of drillers for oil and water at all points in the "Red Beds" country at which beds of rock salt are known or suspected to lie buried, in order that samples of brines and salt and of the rocks adjacent to the salt beds may be sent to the Survey for rough tests as to their possible content of potash salts in commercial amounts. In passing, it may be noted that the studies in this region point to the presence in western Texas, eastern New Mexico, western Oklahoma, and southern Kansas of one of the greatest rock-salt reserves of this continnent, if not of the world.

In this year, as in previous years, field examinations were made of all reported deposits of potash salts or nitrates that the samples or other information showed were worthy of field investigation and tests. The alunite deposits near Marysvale, Utah, were reexamined, and a report was published giving rough quantitative estimates of the quantity of potash they contain. Further, to supply a growing demand by chemical engineers for information as to the possibility of extracting potash and other products from various potash silicate rocks, field examinations, with adequate sampling for chemical analysis in the Survey laboratory, have been made of the greensands of New Jersey, Delaware, Maryland, and western Tennessee and of the sericite deposits in North Carolina and Georgia. During the year a paper calling attention to the potash content of tailings of certain copper and gold ores was published.

THE MINING-DÉBRIS PROBLEM.

A notable contribution to geologic literature in its broadest relations has during this year been completed for publication. The report, which will be issued during the coming year, is entitled "Hydraulic mining débris in the Sierra Nevada" and represents an extremely thorough investigation by Grove Karl Gilbert. To illustrate the scope of the investigation and of the report now completed, the circumstances under which this work was begun should be mentioned. In a memorial presented to the President of the United States in 1905, the California Miners' Association, after emphasizing the contribution of placer and hydraulic mining to California and to the Nation, expressed the conviction that a rational application of the natural laws governing the deposition of sediment from torrential streams would permit both hydraulic mining and agriculture to be carried on in this region, not only without prejudice to each other, but to their mutual advantage. In the belief that the question was primarily geologic, as it involves the study of erosion and of sedimentation in the mining districts as well as in the lower valley regions, the association requested that the Director of the United States Geological Survey should be instructed "to undertake a particular study of those portions of the Sacramento and San Joaquin valleys affected by the detritus from torrential streams."

The investigation then begun by Mr. Gilbert was planned to include a field study of the natural phenomena connected with the problem and a laboratory study of the laws of transportation of detritus by running water. The results of this laboratory study have already been published in the Survey's Professional Paper 86—"The transportation of débris by running water"—and the report just prepared, which deals with the geologic and physiographic phases of the problem. presents the results of the completed investigation and contains conclusions much broader than the answers to the specific questions raised by the California Miners' Association.

This report, which will be published as Professional Paper 105, will rank as one of the largest contributions of the United States Geological Survey to geologic and engineering science and will also assist materially in solving this problem, which involves mining, agriculture, and navigation. To make such an investigation eminently successful, it has been necessary that the investigator should unite an aptitude for close observation and for logical interpretation with a habit of determining quantitatively as many as possible of the factors of the problem in hand. To his task Mr. Gilbert has brought these qualities in a marked degree, with the result that his report is a masterpiece wherein geology and engineering both contribute to the solution of a practical problem of the first rank. Especially important has it been that this subject should be viewed with the broad outlook of the geologist who appreciates the time factor that enters to so large a degree into any reaction of crustal change, erosion, and sedimentation. The studies cover every phase of the subject, from the original source of the detritus in the Sierra Nevada to the possibility of its transportation through the Golden Gate to the Golden Gate Bar, and in his broad treatment Mr. Gilbert has not only estimated the waste due to agriculture, grazing, roads and trails, and mining and studied its movement seaward, but he has supplemented his observations and estimates with instrumental surveys of impounded detritus as well as with measurements of tidal currents in the Golden Gate. This investigation utilizes the results of the earlier work by the Army engineers and has also had the benefit of generous cooperation by the officials of the United States Coast and Geodetic Survey, the United States Weather Bureau, the Lighthouse Service, and the United States Board of Engineers for Rivers and Harbors.

The investigator appreciated the fact that the problem intrusted to him was complex, involving many factors other than those directly connected with mining, and recognized that the beneficial use of these rivers, now overburdened with débris, must be effected by cooperative endeavor on the part of several interests. The public interest in agricultural reclamation, as well as in placer mining, must now be harmonized with the public interest in navigation. In its conclusions, therefore, this scientific study, which had its origin in the antagonism of mining and agriculture, is found to involve a question of relative values between commerce and agriculture, as well as between mining and irrigation and power development. Mr. Gilbert therefore concludes that the great users of the Sierra's water must cooperate in the control of these rivers, to the end that the largest possible benefits may be gained without too great injury to navigation. This report, in which scientific conclusions based on highly technical data are presented in plain and simple terms, serves to illustrate how high a public service can be rendered by the geologist in connection with economic questions of large civic importance.

DISTRIBUTION OF MAPS.

The project of covering the 3,000,000 square miles of the United States with accurate topographic surveys was definitely adopted by the Federal Government in 1882, and the work is even now less than half completed. The standards of accuracy and refinement in topographic surveying have been constantly raised by the topographic engineers, with the view of meeting adequately every use to which the resulting maps can be put. The law provides for the sale of the United States Geological Survey maps at the cost of printing, a charge that must be considered merely nominal when it is realized that the cost of an edition of the printed map may be only a small percentage of the cost of surveying the area it represents. The Government itself is making a large and increasing use of these topographic maps, but the expenditure of public funds for these surveys is otherwise fully warranted only as the public uses the maps. To promote this use, the Survey has recently given more attention to the wider distribution of the maps.

The distribution of a Government map is largely a problem of publicity, though the necessity of adopting commercial business methods in handling orders for the maps when once a demand is created must not be overlooked. In informing the public of the existence of authoritative maps published by the Federal Government a special effort is now made to reach the communities in each area covered by a map, and to this end every map as issued is brought to the attention of the local and State press, as well as of postmasters and schoolteachers. Other methods of promoting wider distribution involve the cooperation of boy-scout masters, schoolboys, and hotel managers, as well as of a large number of bookstores as local agents.

Within the last year the most helpful publicity has been gained through the voluntary cooperation of several press services and magazines of large circulation, in connection with their policy of bringing the people into closer touch with the work and publications of the Federal Government. The publication in one magazine of a brief statement regarding the Geological Survey's maps resulted within a month in orders for 550 maps and thousands of inquiries for the State indexes that show the areas already mapped.

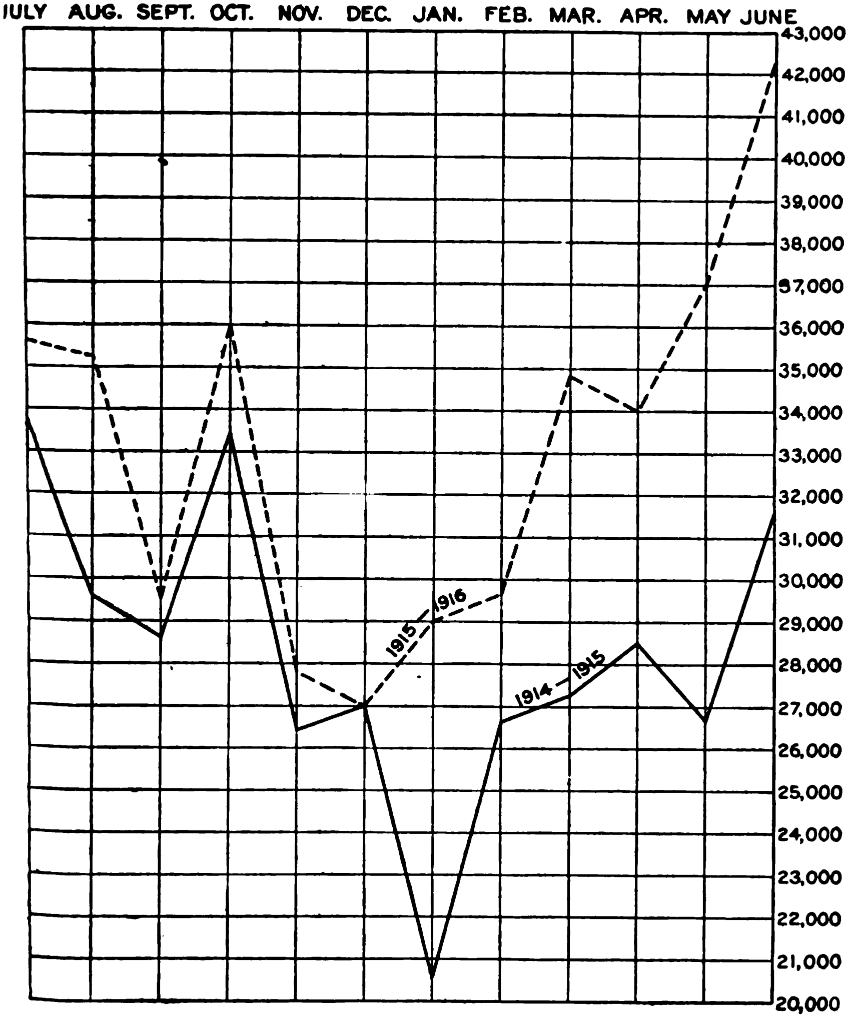

FIGURE 1.—Diagram showing maps sold during the fiscal years 1915 and 1916.

Figure 1 shows a large increase in the number of maps sold in 1915–16 over the number sold in 1914–15. This increase amounted to about 17 per cent. The two curves also bring out the fact that the periods of maximum demand for these Government maps are th beginning of the vacation period and the beginning of the schoo year. The larger use of topographic maps in 1915–16, both in th open and in the classroom, is a gratifying index of the popula benefit already resulting from the increase in the work of publicity

It may be noted here that the sales of Survey publications by th Superintendent of Documents have increased from 10,841 books amounting to $3,689.55, in 1914–15, to 16,348 books, amounting t $8,620.35, in 1915–16.

SCOPE OF THE WORK.

In this administrative report the activities of each branch of th Survey are set forth in detail; the following paragraph is a brie summary of the whole. Geologic investigations were made in 4 States, Alaska, the Canal Zone, and the West Indies; topographic surveys were made in 29 States, Alaska, and Hawaii; and stream measurements were made in 39 States, Alaska, and Hawaii. The total area covered by the geologists in reconnaissance and detailed surveys was more than 54,000 square miles, and the area topographically mapped by the topographers was more than 33,000 square miles The land-classification work of the Geological Survey last yea resulted in the classification of about 32,000,000 acres in the public-land States. In the collection of statistics of mineral production the Geological Survey cooperated with the State geologists of 14 States and carried on correspondence with 92,000 producers.

WORK OF THE YEAR.

PUBLICATIONS.

The publications of the year consisted of 1 annual report, 1 monograph, 2 professional papers, 15 separate chapters from 2 professional papers, 35 bulletins, 45 separate chapters from six bulletins, 24 water-supply papers, 9 separate chapters from 5 water-supply papers, 1 annual report on mineral resources for 1914 (published also in 61 advance chapters, 5 delivered in 1914–15 and 56 in 1915–16), 13 advance chapters from the annual report on mineral resources for 1915, 6 geologic folios, 1 list of publications, pamphlets entitled "Service Bulletin, 1915," and "Extracts from the Style Book of the Government Printing Office," leaflets entitled "The production of copper in 1915," "The production of lead in 1915," and "The production of spelter in 1915," text for back of map entitled "Origin of Delaware Water Gap and of the surrounding features," 3 circulars concerning maps and folios, 33 index map circulars, 81 press bulletins, and 13 circular lists of new publications. The total number of pages in these publications was 19,722.

Brief notes on the publications of the year are given below:

THIRTY-SIXTH ANNUAL REPORT OF THE DIRECTOR of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1915. 1915. 186 pages, 2 plates.

A detailed account of the work of the Geological Survey during the fiscal year 1915, with a statement of the total appropriation made by Congress for the Survey and the allotments for each kind of work. Under the heading "Special features" the Director discusses the larger public service that is every year being rendered by the Survey and the increasing demand for such service and describes briefly the Survey's exhibit at the Panama-Pacific Exposition, San Francisco. The book also includes abstracts of the publications of the year and maps of the United States showing areas covered by topographic and geologic surveys.

MONOGRAPH 54. The Mesozoic and Cenozoic Echinodermata of the United States, by W. B. Clark and M. W. Twitchell. 1915. 341 pages, 108 plates.

This contribution to American paleontology contains descriptions and halftone illustrations of many species and varieties of echinoderms found in the United States. The senior author of the work was the first American to attempt a general systematic study of the Mesozoic and Cenozoic representatives of this group, his first important paper on this subject being "The Mesozoic Echinodermata of the United States," published in 1893 as Bulletin 97 of the United States Geological Survey. Some of the forms of the Echinodermata are very numerous and because of their wide geographic and restricted geologic range are valuable in determing questions of correlation. The revision presented in this contribution should therefore be of some value in stratigraphic geology. Monograph 54 also contains tables showing the stratigraphic positions of the more important American Mesozoic formations, the geologic distribution of the Mesozoic Echinodermata of the United States, and the stratigraphic distribution of the Cretaceous Echinodermata of Texas.

PROFESSIONAL PAPER 89. The fauna of the Chapman sandstone of Maine, including descriptions of some related species from the Moose River sandstone, by H. S. Williams, assisted by C. L. Breger. 1916. 347 pages, 27 plates, 2 text figures.

A study of the fossils of the Chapman sandstone of Maine with a view to correlating this formation with certain others of New York, New England, and Europe, which appear to be of the same horizon. The species are discussed and illustrated in detail.

PROFESSIONAL PAPER 95. Shorter contributions to general geology, 1915; David White, chief geologist. 1916. 120 pages, 7 plates, 35 text figures.

A consolidation of nine short papers issued first as parts A to I, inclusive, forming the third annual volume bearing this title. The papers of this series relate to any phase of geology that possesses general interest, and only their brevity prevents the separate publication of each as a bulletin or professional paper. Professional Paper 95 contains the following contributions: The composition of muds from Columbus Marsh, Nev., by W. B. Hicks; Eocene glacial deposits in southwestern Colorado, by W. W. Atwood; Relation of the Cretaceous formations to the Rocky Mountains in Colorado and New Mexico, by W. T. Lee; An ancient volcanic eruption in the upper Yukon basin, by S. R. Capps; Evaporation of potash brines, by W. B. Hicks; Erosion intervals in the Eocene of the Mississippi embayment, by E. W. Berry; Preliminary report on the diffusion of solids, by C. E. Van Orstrand and F. P. Dewey; Notes on the geology of Gravina Island, Alaska, by P. S. Smith; The age of the Ocala limestone, by C. W. Cooke.

Professional Paper 98–A. Evaporation of brine from Searles Lake, Cal., by W. B. Hicks. 1916. Pp. 1–8, figs. 1–2.

Part of Professional Paper 98, "Shorter contributions to general geology, 1916." Discusses the effect of evaporation on the brine from a bed of crystalline salts in southeastern California known as Searles Lake. This is the most valuable potash-bearing brine known in the United States, so that economical methods for extracting potash and other commercial salts from it are now eagerly sought. The experiments described in this paper were made in continuation of those on artificial brines described in Professional Paper 95–E, "Evaporation of potash brines," by the same author.

Professional Paper 98–B. Relation of the Wissahickon mica gneiss to the Shenandoah limestone and Octoraro schist of the Doe Run and Avondale region, Chester County, Pa., by E. F. Bliss and A. I. Jonas. 1916. Pp. 9–34, Pls. I–III, figs. 3–5.

Describes briefly the geology of a part of the Coatesville quadrangle, in Chester County, Pa., giving special attention to the age of the different rocks. The authors conclude that the Wissahickon mica gneiss, one of the formations occurring in this area, is of pre-Cambrian age and that it is separated from the Shenandoah limestone and Octoraro schist, which are of Cambrian and Ordovician age, by a thrust fault that has been obscured by post-Ordovician metamorphism.

Professional Paper 98–C. Retreat of Barry Glacier, Port Wells, Prince William Sound, Alaska, between 1910 and 1914, by B. L. Johnson. 1916. Pp. 35–36, Pls. IV–V, figs. 6–7.

A brief account of the recession of an Alaskan glacier which in 1899 nearly closed Doran Strait, the connecting waterway between Harriman Fiord and Port Wells. The total retreat of Barry Glacier in the four years between 1910 and 1914 was about 8,200 feet along its eastern edge and 2,500 feet along its western edge.

Professional Paper 98–D. Experiments on the extraction of potash from wyomingite, by R. C. Wells. 1916. Pp. 37–40.

Describes laboratory experiments with the rock wyomingite, made to determine its value as a source of potash. Wyomingite is a lava which occurs extensively in the Leucite Hills, in Sweetwater County, Wyo. It is composed largely of the mineral leucite, a silicate of alumina and potash which is richer in potash than feldspar, long regarded as one of the most promising prospective sources of potash.

Professional Paper 98–E. The physical conditions and age indicated by the flora of the Alum Bluff formation, by E. W. Berry. 1916. Pp. 41–59, Pls. VII–X, fig. 8.

This paper describes a small flora collected from the Alum Bluff formation, which occurs at a horizon hitherto unrepresented paleobotanically in southeastern North America, and discusses the bearing of this flora on the physical conditions of deposition and the probable age of the deposits.

Professional Paper 98–F. The physical conditions indicated by the flora of the Calvert formation, by E. W. Berry. 1916. Pp. 61–73, Pls. XI–XII.

Gives a summary of the small flora preserved in the Miocene diatomaceous beds of the Calvert formation in the District of Columbia and Virginia and discusses its bearing on the physical conditions of the Calvert epoch.

Professional Paper 98–G. Revision of the Beckwith and Bear River formations of southeastern Idaho, by G. R. Mansfield and P. V. Roundy. 1916. pp. 75–84, Pls. XIII–XIV.

Gives a statement of the stratigraphic problems involved in attempting to correlate certain strata of the Wayan and Montpelier quadrangles, Idaho, with the Beckwith and Bear River formations as now defined. The lack of agreement, both lithologically and faunally, between these formations as exposed in the quadrangles named and in the region of their type localities has caused doubt as to whether they have been properly classified.

PROFESSIONAL PAPER 98-H. The flora of the Fox Hills sandstone, by F. H. Knowlton. 1916. Pp. 85-93, Pls. XV-XVIII.

Brief descriptions of the known fossil flora of the Fox Hills sandstone in the Rocky Mountain region. Although only 13 forms have thus far been recognized, a discussion of the affinities and relations of this flora should arouse considerable interest, because the Fox Hills sandstone lies between formations that have furnished abundant plant remains, and knowledge of its flora has long been desired.

BULLETIN 565. Results of spirit leveling in Colorado, 1896 to 1914, inclusive; R. B. Marshall, chief geographer. 1915. 192 pages, 1 plate.

BULLETIN 568. Results of spirit leveling in Missouri, 1896 to 1914, inclusive; R. B. Marshall, chief geographer. 1915. 219 pages, 1 plate.

BULLETIN 573. Results of spirit leveling in Arizona, 1899 to 1915, inclusive; R. B. Marshall, chief geographer. 1915. 123 pages, 1 plate.

Reports on precise and primary leveling in the States mentioned, showing the exact altitude above sea level of a great number of places. The work in Missouri since 1906 was done in cooperation with the State. Some of these elevations have been adjusted by the United States Coast and Geodetic Survey from precise leveling. Others (in Missouri) are elevations of stone-line bench marks established by the Mississippi River Commission and by the Missouri River Commission from primary leveling. Each book contains a plate showing Geological Survey designs for bench marks.

BULLETIN 587. Geology and mineral resources of Kenai Peninsula, Alaska, by G. C. Martin, B. L. Johnson, and U. S. Grant. 1915. 243 pages, 38 plates, 43 text figures.

A concise summary of what is known of the geography, geology, and mineral resources of Kenai Peninsula, Alaska, based on investigations made at different times by many observers. Kenai Peninsula contains auriferous lodes of some promise, though deep mining has so far been done on only a small scale. The future of placer mining in this part of Alaska depends on the exploitation of many large bodies of gravel carrying too little gold to permit development by the simple methods thus far chiefly used. The book contains numerous illustrations, which include a map of central Alaska, topographic and geologic reconnaissance maps of Kenai Peninsula, a map showing distribution of timber, and sketches and photographs showing features of geologic interest.

BULLETIN 591. Analyses of rocks and minerals from the laboratory of the United States Geological Survey, 1880 to 1914, tabulated by F. W. Clarke, chief chemist. 1915. 376 pages.

A compilation of chemical analyses of rocks, clays, and soils, arranged by States, and of meteorites and minerals.

BULLETIN 593. The fauna of the Batesville sandstone of northern Arkansas, by G. H. Girty. 1915. 170 pages, 11 plates.

Descriptions of invertebrate fossils of a section of upper Mississippian rocks in northern Arkansas, lying just above the Moorefield shale, whose fauna has been described in Bulletin 439 by the same author.

BULLETIN 595. Fauna of the so-called Boone chert near Batesville, Ark., by G. H. Girty. 1915. 45 pages, 2 plates.

The fossils that form the subject of this account are poorly preserved and as a fauna comprise little that is new. They occur in rocks of Mississippian age whose outcrops were studied in the vicinity of Batesville, Ark. The noteworthy thing about this fauna is that practically all the species occur also in the Moorefield shale. which lies just above the chert, and practically none of them occur in the typical Boone limestone. This would indicate that the cherty limestone is younger than the true Boone and should really be classed as a distinct formation.

BULLETIN 598. Faunas of the Boone limestone at St. Joe, Ark., by G. H. Girty. 1915. 50 pages, 3 plates.

This bulletin consists of two distinct parts—one describing the fauna of the St. Joe limestone member of the Boone limestone, the other describing a small fauna obtained in the Boone not far above the St. Joe. These rocks are of lower Mississippian age. The collections of fossils described in both papers were obtained near the town of St. Joe, in northern Arkansas. Many of the forms are illustrated in the halftone plates which accompany the report.

BULLETIN 601. Geology and mineral deposits of the National mining district, Nev., by Waldemar Lindgren. 1915. 58 pages, 8 plates, 8 text figures.

Discusses briefly the geology of the Santa Rosa Range, a narrow desert mountain range of northwestern Nevada, in general, and of the National mining district, on the western slope of this range, in particular. Gives detailed descriptions of developments in the district. Special interest attaches to the description of the extraordinary shoot of rich gold ore which brought the district into prominence in 1909 and to the conclusion that the high-grade ores of National, like those of Goldfield, were deposited within a comparatively short distance from the surface. The illustrations include a geologic map of the National district, a map of the National mine, diagrams and sections of the National vein, and photomicrographs of gold quartz.

BULLETIN 602. Anticlinal structure in parts of Cotton and Jefferson counties, Okla., by C. H. Wegemann. 1915. 108 pages, 5 plates.

A reconnaissance report whose object is to offer first aid to the prospector for oil in the region discussed. The anticlines and domes pointed out are believed to be the most promising areas of the region for testing, for nearly everywhere in Oklahoma accumulations of oil and gas are associated with such features of structure, though their exact relations to these features vary from area to area and even from pool to pool. Incomplete as the results necessarily are, on account of the difficulties encountered, the work of the State and Federal surveys will have been many times repaid if the use of this report will prevent a large part of the fruitless drilling that usually attends the geologically unaided search for oil and gas in undeveloped areas. The illustrations of the bulletin include a geologic sketch map of Oklahoma and northern Texas, showing the location of oil and gas fields, and a geologic map of parts of Cotton and Jefferson counties, Okla., showing structure. The report was prepared in cooperation with the Oklahoma Geological Survey.

BULLETIN 603. Geology and oil resources of the west border of the San Joaquin Valley north of Coalinga, Cal., by Robert Anderson and R. W. Pack. 1915. 219 pages, 14 plates, 5 text figures.

The main purpose of this report is to present the geologic evidences of the existence of petroleum in the rocks along the foothills that form the western border of San Joaquin Valley, Cal., between the Coalinga oil district and Livermore Pass, and to discuss the chances of finding oil in commercial quantity in this region. With this end in view, a general description of the physical features of the region is given, with special reference to the geologic features which have a bearing on the presence or absence of petroleum in the several areas considered. The writers take this opportunity of presenting also some additional geologic information, which may be of interest to the geologist if not to the oil prospector. The illustrations show many interesting geologic features and include a geologic map, with sections, of the valley between the Coalinga oil field and Livermore Pass.

BULLETIN 604. The phosphate deposits of Florida, by G. C. Matson. 1915. 101 pages, 17 plates, 2 text figures.

A brief summary of the geology of the northern part of the Florida Peninsula, followed by a discussion of the mode of occurrence, geologic relations, and origin of the phosphates which occur there and methods of mining them. Numerous halftone plates give views of the deposits and of fossils found in them.

BULLETIN 605. The Ellamar district, Alaska, by S. R. Capps and B. L. Johnson. 1915. 125 pages, 10 plates, 10 text figures.

This report gives the results of a detailed study of the geology and ores of the Ellamar district, which lies at the northeast border of Prince William Sound and includes part of the mainland, about half of Bligh Island, and a number of smaller islands. The Prince William Sound region is now one of the larger copper producers of Alaska and promises to hold that position, so that any information as to its very complex geology is of considerable importance. Bulletin 605 discusses the mines and prospects of the Ellamar district and contains detailed topographic and geologic maps of the area.

BULLETIN 606. Origin of the zinc and lead deposits of the Joplin region, Missouri, Kansas, and Oklahoma, by C. E. Siebenthal. 1915. 283 pages, 11 plates.

A valuable contribution to the study of the lead and zinc deposits of the Mississippi Valley, which are not only of great economic importance but have long been intensely interesting to students of ore deposits because they constitute a conspicuous example of the occurrence of sulphide ores in a region where plutonic or volcanic activities can have had no part in their genesis. The author holds that the Joplin ores were segregated from disseminated zinc and lead minerals in the Cambrian and Ordovician rocks of the Ozark uplift by circulating artesian alkaline-saline sulphureted waters, and his careful observations and cogent reasoning have gone far to establish the general conclusion that ordinary cold artesian water may under some circumstances be a very efficient agent in the solution, transportation, and deposition of the constituents of certain sulphide ores. The illustrations include topographic and geologic maps and cross sections of the Ozark uplift, diagrams showing early and late stages in Ozark artesian circulation, and halftone plates showing the manner of occurrence of the ores in certain of the mines.

BULLETIN 607. The Willow Creek district, Alaska, by S. R. Capps. 1915. 86 pages, 15 plates, 5 text figures.

Describes the geography and geology of the Willow Creek district, which lies in south-central Alaska, about 10 miles north of the head of Knik Arm, and includes not only the basin of Willow Creek, but all the mountainous portion of the Little Susitna River basin. The author points out that the geology of this area is favorable to the occurrence of gold deposits, so that the outlook for a permanent lode district here is hopeful. Each mine and prospect is treated in detail, and the book contains many halftone plates, as well as topographic and geologic maps, showing features of interest to the miner and geologist.

BULLETIN 608. The Broad Pass region, Alaska, by F. H. Moffit, with sections on Quaternary deposits, igneous rocks, and glaciation by J. E. Pogue. 1915. 80 pages, 8 plates, 3 text figures.

Describes briefly the geography and geology of the Broad Pass region, Alaska, which includes the headwater tributaries of Chulitna and Nenana rivers and the heads of some streams flowing into Susitna River. Broad Pass, a wide glaciated valley between the head of Chulitna River and Jack River, a tributary of the Nenana, was discovered in 1898 by members of the United States Geological Survey and has recently been chosen as the route of the proposed Government railroad from Seward to Fairbanks. Although no commercial mineral deposits have yet been found in this region, what is known of the geology gives hope that such deposits may be found. The book is illustrated by topographic and geologic reconnaissance maps and views showing geologic conditions in the area described.

BULLETIN 609. The fractional precipitation of some ore-forming compounds at moderate temperatures, by R. C. Wells. 1915. 46 pages, 2 text figures.

The experiments described in this bulletin were made to aid in elucidating the chemistry of ore deposition. As the solubility of a compound in water is the factor that most affects the separation and deposition of its ore-forming constituents, these experiments were confined to aqueous solutions at moderate temperatures, and they have shown the order of solubility of the compounds of each of the classes investigated—sulphides, hydroxides, carbonates, and silicates. For the sake of comparison the results obtained are assembled in tabular form at the end of the book.

BULLETIN 610. Mineralogic notes, series 3, by W. T. Schaller. 1916. 164 pp., 5 plates, 99 text figures.

Gives results of the author's mineralogic research work in the chemical laboratory of the United States Geological Survey from July, 1911, to December, 1913. Describes and shows the crystal forms of several new minerals, the most interesting of which is probably koechlinite, a bismuth molybdate found first at Schneeberg, Germany. Series 1 and 2 of these notes were published as Bulletins 490 and 509.

BULLETIN 611. Guidebook of the western United States, Part A, The Northern Pacific Route, with a side trip to Yellowstone Park, by M. R. Campbell and others. 1915. 212 pages, 27 route maps, 27 plates, 39 text figures.

The first of a series of handbooks for railway travelers in the Western States, describing the geography, geology, history, and natural resources of the region traversed by the principal transcontinental routes. The present volume deals with the country along the Northern Pacific Railway from St. Paul to Seattle and along the branch line to Yellowstone Park.

He is a very unobservant traveler who can cross the Great Plains, the Rocky Mountains, the lava plateau of the Columbia, and the Cascade Range without noting some of the diversities in the color and character of the rocks and the striking differences in the landscape. It is the purpose of this volume to answer some of the questions which these views from the car windows evoke, to tell what the rocks are and how they got there, to explain the effects of earth movements upon them, to show how that conspicuous element in scenery which we call topography is the result of a long succession of geologic events—in brief, to tell the story of the mountains, valleys, and plains. It does not stop there, however. It connects this record of the prehistoric past with the present march of western progress and development by showing the relation of geologic processes to natural resources of various kinds; it describes the utilization of these resources and tells how man has turned them to account since Lewis and Clark toiled over the route that is now so quickly traversed in luxurious comfort.

Every effort has been made to make the volume interesting as well as accurate. Matter slightly more detailed or technical than that in the body of the text has been separated as footnotes, and a glossary has been provided for such geologic terms as it was necessary to use. The more important sources of geologic information on the region are listed in the back of the book, and a table showing the principal divisions of geologic time appears on the back of the title-page. Each map unfolds so that it can be consulted conveniently without turning the page which the traveler may be reading. The halftone views and text figures have been chosen with care to convey definite information.

BULLETIN 613. Guidebook of the western United States, Part C, The Santa Fe Route, with a side trip to the Grand Canyon of the Colorado, by N. H. Darton and others. 1915. 194 pages, 25 route maps, 42 plates, 40 text figures.

This guide describes the country along the Atchison, Topeka & Santa Fe Railway from Kansas City to Los Angeles. It presents the facts in an itinerary from station to station, and although the description of the rocks and their relations and of the scenic features forms a large proportion of the matter, nearly every page gives information as to notable historic events, industrial resources, plants, and animals. The story of the Indians, past and present, especially the characteristic Pueblo tribes, is told in some detail. The treatment is popular, and many interesting facts are presented, making the book easy reading. Some of the more technical data are given in footnotes and diagrams. The 25 maps covering the route not only show the main features of mountains and valleys, plains and rivers within sight from the railway, but give figures of elevation and distance, and the distribution of the rocks is indicated by a separate color. Many of the facts regarding the rocks are here presented for the first time. The book contains numerous views of prominent scenic features and pictures of restorations of some of the very remarkable animals whose bones are found in the clays. A glossary of geologic terms and a table of the larger divisions of geologic time are included. A list of recent geologic literature relating to the region serves as a guide to more detailed reading.

BULLETIN 614. Guidebook of the western United States, Part D, The Shasta Route and Coast Line, by J. S. Diller and others. 1915. 142 pages, 19 route maps, 33 plates, 15 text figures.

A manual for the traveler between Seattle or Los Angeles and San Francisco, which describes in clear, simple language the geography, geology, history, and natural resources of the region visible from the car windows. Geology is made interesting to the reader by an avoidance of details and by the selection for treatment of the features that are likely to attract the eye. Care is taken also to point out the connection between the story of the earth and the present human activity in the region.

The book is divided into two parts, one dealing with the route from Seattle to San Francisco and one with the route from Los Angeles to San Francisco. Both routes go through regions that present great diversity in geology, scenery, climate, and resources. For the northern route the history of civilized settlement goes back to the early fur traders and trappers, and for the southern route to the Spanish padres and their Indian converts. As in the other guidebooks in this series the route is covered by convenient maps and the text is well illustrated by views and diagrams.

BULLETIN 615. Rhode Island coal, by G. H. Ashley. 1915. 62 pages, 5 plates. 8 text figures.

A brief discussion of the character and attempted utilization of Rhode Island coal, which has always had a certain interest to the people of that State as a source of local supply in competition with Pennsylvania coal. The author concludes that, as this coal is a high-ash, high-moisture, graphitic anthracite which requires peculiar handling, the best prospect for its present use is in producing electric power at the mines, either in steam engines or by means of specially devised producer-gas or water-gas plants. He adds that this can probably not be done until Rhode Island coal can be mined and delivered at the furnace for less than one-half the wholesale price of competing coals in Providence and Boston. The illustrations consist of a sketch map of the Rhode Island coal field, views at several of the mines, and charts showing the composition and theoretical heating power of Rhode Island coal as compared to its competitors and the relation of its carbon content to its fuel value.

BULLETIN 616. The data of geochemistry (third edition), by F. W. Clarke. 1915. 821 pages.

A manual of geologic chemistry, including chapters on the nature, distribution, and relative abundance of the chemical elements, the composition of the atmosphere and of volcanic gases and sublimates, the mineral content of surface and underground waters, the nature of saline residues, the molten magma of the earth's interior, the rock-forming minerals, the composition of igneous, sedimentary, and metamorphic rocks, the decomposition of rocks, the metallic ores, the natural hydrocarbons, and coal.

BULLETIN 617. Bibliography of North American geology for 1914, with subject index, by J. M. Nickles. 1915. 167 pages.

A list, arranged alphabetically by authors' names, of publications on the geology of the continent of North America and adjacent islands, also Panama and the Hawaiian Islands, issued in 1914. The work is indexed and contains lists of chemical analyses reported and minerals, rocks, and formations described.

BULLETIN 618. Geology and underground waters of Luna County, N. Mex., by N. H. Darton. 1916. 188 pages, 13 plates, 15 text figures.

Describes the geologic structure of Luna County, in southwestern New Mexico, with the especial purpose of showing the extent of the area underlain by water-bearing deposits, the depth of these deposits, and the amount of water available. This information was much needed because of the arrival in the desert valleys of this region of new settlers who had come with the expectation of using underground water for irrigation. A list of the wells in each township is given and some of them are briefly described. The illustrations include a geologic map of Luna County, geologic sections across certain of the mountains, and halftone plates showing methods of irrigation.

BULLETIN 619. The Caddo oil and gas field, La. and Tex., by G. C. Matson. 1916. 62 pages, 8 plates, 5 text figures.

Describes the stratigraphic and structural geology of the Caddo oil and gas field, which lies mainly in Caddo Parish, northwestern Louisiana, with especial reference to the occurrence, accumulation, and source of the oil and gas. The illustrations include a map of the Caddo field, sections showing simple types of structure in this district, and logs of the wells.

Bulletin 620. Contributions to economic geology (short papers and preliminary reports), 1915, Part I, Metals and nonmetals except fuels; F. L. Ransome and H. S. Gale, geologists in charge. 1915. 361 pages, 12 plates, 22 text figures.

This bulletin includes sixteen brief reports of two classes—(1) short papers giving comparatively detailed descriptions of occurrences that have economic interest but are not of sufficient importance to warrant a more extended description; (2) preliminary reports on economic investigations the results of which are to be published later in more detailed form. These papers are such only as have a direct economic bearing, all topics of purely scientific interest being excluded. Each paper has been issued as an advance chapter as soon as it was ready. A list of the papers, arranged according to subjects, is given below.

Gold and silver.

A gold-platinum-palladium lode in southern Nevada, by Adolph Knopf.

Gold deposits near Quartzsite, Ariz., by E. L. Jones, jr.

A reconnaissance in the Kofa Mountains, Ariz., by E. L. Jones, jr.

A reconnaissance of the Cottonwood-American Fork mining region, Utah, by B. S. Butler and G. F. Loughlin.

Notes on the fine gold of Snake River, Idaho, by J. M. Hill.

Preliminary report on the economic geology of Gilpin County, Colo., by E. S. Bastin and J. M. Hill.

The Aztec gold mine, Baldy, N. Mex., by W. T. Lee.

Iron.

Iron ore in Cass, Marion, Morris, and Cherokee counties, Tex., by E. F. Burchard.

Iron-bearing deposits in Bossier, Caddo, and Webster parishes, La., by E. F. Burchard.

Quicksilver.

Some cinnabar deposits in western Nevada, by Adolph Knopf.

Quicksilver deposits of the Mazatzal Range, Ariz., by F. L. Ransome.

Potash.

Potash in certain copper and gold ores, compiled by B. S. Butler.

Recent alunite developments near Marysvale and Beaver, Utah, by G. F. Loughlin.

Miscellaneous.

Nitrate deposits in southern Idaho and eastern Oregon, by G. R. Mansfield.

A reconnaisance for phosphate in the Salt River Range, Wyo., by G. R. Mansfield.

Cassiterite in San Diego County, Cal., by W. T. Schaller.

Bulletin 621. Contributions to economic geology, 1915, Part II; advance chapters as follows:

Bulletin 621–A. Field apparatus for determining ash in coal, by C. E. Lesher. 1915. Pp. i–ii, 1–12, Pls. I–II, figs. 1–2.

Bulletin 621–B. The Healdton oil field, Carter County, Okla., by C. H. Wegemann and K. C. Heald. 1915. Pp. i–ii, 13–30, Pls. III–V, fig. 3.

Bulletin 621–C. The Loco gas field, Stephens and Jefferson counties, Okla., by C. H. Wegemann. 1915. Pp. i–iv, 31–42, Pls. VI–VII, fig. 3.

Bulletin 621–D. The Duncan gas field, Stephens County, Okla., by C. H. Wegemann. 1915. Pp. i–iv, 43–50, Pls. VIII–IX, fig. 3.

Bulletin 621–E. A reconnaissance in Palo Pinto County, Tex., with special reference to oil and gas, by C. H. Wegemann. 1916. Pp. i–ii, 51–59, figs. 4–5.

Bulletin 621–F. Possibilities of oil in the Porcupine dome, Rosebud County, Mont., by C. F. Bowen. 1915. Pp. i–ii, 61–70, Pl. X, fig. 6.

Bulletin 621–G. The Lawton oil and gas field, Okla., by C. H. Wegemann and R. W. Howell. 1915. Pp. i–iv, 71–85, Pls. XI–XII, fig. 3.

Bulletin 621–H. Anticlines in the Clinton sand near Wooster, Wayne County, Ohio, by C. A. Bonine. 1915. Pp. i–ii, 87–98, Pl. XIII.

Bulletin 621–I. The Orofino coal field, Clearwater, Lewis, and Idaho counties, Idaho, by C. T. Lupton. 1915. Pp. i–ii, 99–108, figs. 7–8.

Bulletin 621–J. A reconnaissance for oil near Quanah, Hardeman County, Tex., by C. H. Wegemann. 1915. Pp. i–ii, 109–115, Pl. XIV, fig. 9.

Bulletin 621–K. Geology and coal resources of northern Teton County, Mont. by Eugene Stebinger. 1916. Pp. i–iii, 117–156, Pls. XV–XVI, fig. 10.

Bulletin 621–L. Oil and gas near Basin, Big Horn County, Wyo., by C. T. Lupton. 1916. Pp. i–ii, 157–190, Pls. XVII–XVIII, fig. 11.

Bulletin 621–M. Geology and oil prospects of Cuyama Valley, Cal., by W. A. English. 1916. Pp. i–iii, 191–215, Pls. XIX–XXI, fig. 12.

Bulletin 621–N. Structure of the Berea oil sand in the Summerfield quadrangle, Guernsey, Noble, and Monroe counties, Ohio, by D. D. Condit. 1916. Pp. i–ii, 217–231, Pls. XXII–XXIII, figs. 13–15.

Bulletin 621–O. Structure of the Berea oil sand in the Woodsfield quadrangle, Belmont, Monroe, Noble, and Guernsey counties, Ohio, by D. D. Condit. 1916. Pp. i–iv, 233–249, Pls. XXIV–XXV, figs. 13, 16–17.

Bulletin 621–P. Analyses of coal samples from various parts of the United States, by M. R. Campbell and F. R. Clark. 1916. Pp. i–iv, 251–370.

Bulletin 622. Mineral resources of Alaska—report on progress of investigations in 1914, by A. H. Brooks and others. 1915. 380+xi pages, 11 plates, 8 text figures.

This volume contains a condensed summary both of the results of the investigations of Alaskan mineral resources during 1914 and of the status of the mining industry of the Territory. It is the eleventh of a series of annual bulletins devoted to this subject and is made up of eighteen papers by eight authors. These papers were published separately, but the editions were small.

The arrangement and manner of treatment in this volume are the same as in those previously issued. First, papers of a general character are presented, followed by those treating of special districts, arranged geographically from south to north. One of these papers deals with administrative matters, one is a general summary of the mining industry, one treats of the future of the placer-mining industry, and the remainder deal more specifically with the mineral resources of certain districts. In the geologic papers emphasis is laid on the conclusions having immediate interest to the miner. The titles of the papers are given below:

Preface, by A. H. Brooks.
Administrative report, by A. H. Brooks.
The Alaskan mining industry in 1914, by A. H. Brooks.
The future of gold placer mining in Alaska, by A. H. Brooks.
Tin mining in Alaska, by H. M. Eakin.

Mining in the Juneau region, by H. M. Eakin.

Mineral deposits of the Kotsina-Kuskulana district, with notes on mining in Chitina Valley, by F. H. Moffit.

Auriferous gravels of the Nelchina-Susitna region, by Theodore Chapin.

Mining on Prince William Sound, by B. L. Johnson.

The gold and copper deposits of the Port Valdez district, by B. L. Johnson.

Mineral resources of the Chisana-White River district, by S. R. Capps.

Mining in the Fairbanks district, by H. M. Eakin.

Mining in the Hot Springs district, by H. M. Eakin.

Mineral resources of the Lake Clark-Iditarod region, by P. S. Smith.

Quicksilver deposits of the Kuskokwim region, by P. S. Smith and A. G. Maddren.

Gold placers of the lower Kuskokwim, with a note on copper in the Russian Mountains, by A. G. Maddren.

Iron-ore deposits near Nome, by H. M. Eakin.

Placer mining in Seward Peninsula, by H. M. Eakin.

BULLETIN 623. Petroleum withdrawals and restorations affecting the public domain, by M. W. Ball; compilation by L. W. Stockbridge. 1916. 427 pages, 9 plates.

This bulletin gives true and accurate copies of orders of withdrawal, restoration, modification, and classification of public lands supposed to contain oil. It includes also a short statement of the purpose of the withdrawal policy, a brief review of the history of oil withdrawals, and a chapter on oil-land law, giving the statutes and judicial decisions of interest to the oil operator on the public domain. Maps which accompany the bulletin show the areas withdrawn in each State where oil withdrawals were outstanding January 15, 1916.

BULLETIN 626. The Atlantic gold district and the North Laramie Mountains, Fremont, Converse, and Albany counties, Wyo., papers by A. C. Spencer. 1916. 85 pages, 5 plates, 6 text figures.

These papers describe the geology and ore deposits of two areas in Wyoming lying about 125 miles apart. Although no large mine has been developed in the Atlantic district, gold to the value of $1,500,000 has been produced there, and the district gives promise of further profitable development. Mining in the North Laramie Mountains is still in the prospecting stage, but this district also is worthy of development. Most of the prospecting has been done in the search for copper, but at one locality lead ores have been found, at another chromic iron ore, and at another magnetic iron ore. The illustrations include geologic maps of the districts described and sketch maps showing the location of claims and principal mineral prospects.

BULLETIN 628. Geology and coal resources of Castle Valley, in Carbon, Emery, and Sevier counties, Utah, by C. T. Lupton. 1915. 88 pages, 12 plates, 1 text figure.

Describes briefly the geography and geology of Castle Valley, in east-central Utah, studied in connection with an investigation made to determine the quality and quantity of the coal resources of the valley. The age and thickness of the coal-bearing formations and their relations to the underlying and overlying rocks are discussed, as well as the character of the coal and the development of the valley with respect to mines, prospects, and transportation routes. The illustrations include a geologic map of Castle Valley, sections of several of the coal beds, and halftone plates showing geologic features of the coal-bearing formations.

BULLETIN 629. Natural gas resources of parts of north Texas—Gas in the area north and west of Fort Worth, by E. W. Shaw; Gas prospects south and southeast of Dallas, by G. C. Matson—with notes on the gas fields of central and southern Oklahoma, by C. H. Wegemann. 1916. 126 pages, 7 plates, 13 text figures.

The investigations resulting in this report were made in order to determine the extent of the gas reserve within reach of the cities of Dallas and Fort Worth. The Survey's examination was purely geologic, dealing exclusively with the structure of the areas, the amount of gas already produced, the probable amounts still remaining in the old fields, and the probabilities of discovering new pools sufficient to maintain an adequate supply of gas for these cities for the next decade or more. The bulletin is illustrated by maps of the two principal gas fields in this part of Texas—the Petrolia and the Mexia-Groesbeck—maps showing the geologic structure of the area, and diagrams showing features of the wells of importance to the driller and prospector.

BULLETIN 632. Spirit leveling in West Virginia, 1896 to 1915, inclusive; R. B. Marshall, chief geographer. 1916. 168 pages, 1 plate.

BULLETIN 633. Spirit leveling in Maine, 1899–1915; R. B. Marshall, chief geographer. 1916. 64 pages, 1 plate.

BULLETIN 636. Spirit leveling in Louisiana, 1903 to 1915, inclusive; R. B. Marshall, chief geographer. 1916. 101 pages, 1 plate.

Reports on precise and primary leveling in the States named, showing the exact altitude above sea level of a great many places. Some of these elevations have been adjusted by the United States Coast and Geodetic Survey from precise leveling. The work in Louisiana during 1906 and 1909 was done in cooperation with the State. Each bulletin contains a halftone plate showing Geological Survey designs for bench marks.

BULLETIN 640–A. Notes on the Promontory district, Utah, by B. S. Butler and V. C. Heikes. 1916. Pp. 1–10, figs. 1–2.

Part of Bulletin 640, "Contributions to economic geology, 1916, Part I." A brief sketch of the geography and geology of the Promontory mining district, in Boxelder County, Utah, with a discussion of the ore deposits, chiefly lead and zinc.

BULLETIN 640–C. Some manganese mines in Virginia and Maryland, by D. F. Hewett. 1916. Pp. 37–71, figs. 4–10.

Discusses the manganese deposits of Virginia and Maryland, which have become important since the introduction of the Bessemer process of making steel, because they are accessible to the iron and steel producing centers of the East. Describes half a dozen of the mines in detail and gives sketch maps of their workings.

BULLETIN 641–A. Ozokerite in central Utah, by H. M. Robinson. 1916. Pp. 1–16, Pl. I.

Part of Bulletin 641, "Contributions to economic geology, 1916, Part II." Gives results of an examination of the ozokerite field of Utah, the largest district in the United States in which ozokerite has been mined and prospected. The European war has seriously affected the importation of this material from Austria, so that at present the domestic product can compete favorably with the foreign in American markets. Ozokerite, or mineral wax, is a nonconductor of electricity and is extensively used for insulating. Much of it is converted into ceresin, a highly purified product used to replace or adulterate beeswax, as well as for a variety of other purposes.

BULLETIN 644–A. Primary traverse in Alabama and North Carolina, 1913–1915; R. B. Marshall, chief geographer. 1916. Pp. i–vii, 1–12, Pl. II.

BULLETIN 644–B. Triangulation in Arizona and New Mexico, 1913–1915; R. B. Marshall, chief geographer. 1916. Pp. i–vii, 13–24, Pl. II.

Parts of Bulletin 644, "Triangulation and primary traverse, 1913–1915."

WATER-SUPPLY PAPER 332. Surface water supply of the United States, 1912, Part VII, North Pacific drainage basins; N. C. Grover, chief hydraulic engineer; F. F. Henshaw, G. C. Baldwin, and W. A. Lamb, district engineers. 1916. 748 pages, 2 plates.

Presents briefly the results of measurements of stream flow made in the North Pacific drainage basins during the year ending September 30, 1912. Data for each gaging station are given under the following heads: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Artificial control, Winter flow, Accuracy, and Cooperation. Contains also tables giving gage heights and daily and monthly discharges at each station and halftone plates representing typical gaging stations and current meters. The report was prepared in cooperation with the States of Montana, Idaho, Washington, and Oregon and was issued first in three separate chapters, each covering the drainage basins mentioned in its title, namely:

A. Pacific drainage basins in Washington and upper Columbia River basin, by F. F. Henshaw and W. A. Lamb.

B. Snake River basin, by G. C. Baldwin and F. F. Henshaw.

C. Lower Columbia River and Rogue, Umpqua, and Siletz rivers, by F. F. Henshaw and E. S. Fuller.

WATER-SUPPLY PAPER 340. Stream-gaging stations and publications relating to water resources, 1885–1913, compiled by B. D. Wood. 1916. 195 pages.

A directory of Survey stream-gaging stations and publications relating to water resources of the United States. This report was published in twelve separate parts, each of which contains a list of all gaging stations maintained in the section named in its title and an annotated list of publications issued by the United States Geological Survey relating specifically to that section, as well as a similar list of reports that are of general interest, covering a wide range of hydrologic subjects, and brief references to reports published by State and other organizations. The section of the country covered by each part of Water-Supply Paper 340 is shown below.

I. North Atlantic coast drainage basins
II. South Atlantic coast and eastern Gulf of Mexico drainage basins.
III. Ohio River basin.
IV. St. Lawrence River basin.
V. Hudson Bay and upper Mississippi River drainage basins.
VI. Missouri River basin.
VII. Lower Mississippi River basin.
VIII. Western Gulf of Mexico drainage basins.
IX. Colorado River basin.
X. The Great Basin.
XI. Pacific coast basins in California.
XII. North Pacific slope drainage basins.

WATER-SUPPLY PAPER 345. Contributions to the hydrology of the United States, 1914; N. C. Grover, chief hydraulic engineer. 1915. 225 pages, 17 plates, 24 text figures.

Made up of nine short papers and preliminary reports on the water supply of various sections of the country. Issued first, as received, in the form of separate chapters, in order that the interested public may have early information of the results of investigations made by the hydraulic engineers and geologists of the Geological Survey. A list of the papers included in the volume follows:

Preliminary report on ground water for irrigation in the vicinity of Wichita, Kans., by O. E. Meinzer.

Ground water for irrigation in the vicinity of Enid, Okla., by A. T. Schwennesen, with a note on ground water for irrigation on the Great Plains, by O. E. Meinzer.

Underground water of Luna County, N. Mex., by N. H. Darton, with results of pumping tests, by A. T. Schwennesen.

Ground water for irrigation in the valley of North Fork of Canadian River near Oklahoma City, Okla., by A. T. Schwennesen.

A method of determining the daily discharge of rivers of variable slope, by M. R. Hall, W. E. Hall, and C. H. Pierce.

The discharge of Yukon River at Eagle, Alaska, by E. A. Porter and R. W. Davenport.

The water resources of Butte, Mont., by O. E. Meinzer.

Ground-water resources of the Niles cone and adjacent areas, Cal., by W. O. Clark.

Gazetteer of surface waters of Iowa, by W. G. Hoyt and H. J. Ryan.

WATER-SUPPLY PAPER 351. Surface water supply of the United States, 1913. Part I, North Atlantic coast basins; N. C. Grover, chief hydraulic engineer; C. C. Covert and G. C. Stevens, district engineers. 1915. 189 pages, 2 plates.

WATER-SUPPLY PAPER 352. Surface water supply of the United States, 1913. Part II, South Atlantic and eastern Gulf of Mexico basins; N. C. Grover, chief hydraulic engineer; G. C. Stevens and W. E. Hall, district engineers. 1915. 84 pages, 3 plates.

WATER-SUPPLY PAPER 355. Surface water supply of the United States for the year ending September 30, 1913, Part V, Hudson Bay basins and upper Mississippi River; N. C. Grover, chief hydraulic engineer; W. A. Lamb and W. G. Hoyt, district engineers. 1915. 181 pages, 2 plates.

WATER-SUPPLY PAPER 359. Surface water supply of the United States. 1913, Part IX, Colorado River basin; N. C. Grover, chief hydraulic engineer; Robert Follansbee, E. A. Porter, and G. A. Gray, district engineers. 1915. 260 pages, 2 plates.

WATER-SUPPLY PAPER 362–C. Surface water supply of lower Columbia River and Rogue, Umpqua, Wilson, and Nehalem rivers, 1913; N. C. Grover, chief hydraulic engineer; F. F. Henshaw, district engineer. 1915. 246 pages.

These papers present briefly the results of measurements of stream flow made in the drainage basins in the titles. Data for each gaging station are given under the following heads: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Artificial control, Winter flow, Accuracy, and Cooperation. The books contain also tables giving gage heights and daily and monthly discharges at each station.

WATER-SUPPLY PAPER 369. Water powers of the Cascade Range, Part III, Yakima River basin, by G. L. Parker and F. B. Storey. 1916. 169 pages, 20 plates, 12 text figures.

The third of a series of reports dealing with the water powers on rivers flowing from the Cascade Range in Washington and Oregon. Descriptions of the geologic history, physical characteristics, economic conditions, and industrial development of the region are given, together with a map of the basin, plans and profiles of the streams, stream-flow records, and short discussions of the developed water powers and undeveloped possible sites. The report was prepared in cooperation with the Washington State Board of Geological Survey.

WATER-SUPPLY PAPER 370. Surface water supply of Oregon, 1878–1910, by F. F. Henshaw and H. J. Dean. 1915. 829 pages, 1 plate.

Presents briefly the results of measurements of stream flow made in Oregon from 1878 to 1910, inclusive. As an introduction to the report the natural features of Oregon are discussed. Then follow data for each gaging station under the following heads: Location, Records presented, Drainage area, Gage, Channel, Discharge measurements, Winter flow, Diversions, Rating curves, Extreme stages, Accuracy, and Cooperation. Contains also tables giving gage heights and daily and monthly discharges at each station and a map of Oregon showing the principal rivers.

WATER-SUPPLY PAPER 371. Equipment for current-meter gaging stations, by G. J. Lyon. 1915. 64 pages, 37 plates, 10 text figures.

A technical description, accompanied by numerous precisely drawn plans, of the types of equipment for current-meter gaging stations that have been found most effective in facilitating observations and insuring accurate results. Includes many tables giving bills of material for certain parts of the equipment. The book is designed especially for the use of hydraulic engineers and others interested in stream-flow measurement.

WATER-SUPPLY PAPER 372. A water-power reconnaissance in south-central Alaska, by C. E. Ellsworth and R. W. Davenport, with a section on southeastern Alaska, by J. C. Hoyt. 173 pages, 22 plates, 6 text figures.

This paper presents the results of the first systematic study of the water powers of south-central Alaska, which includes the region tributary to Copper River, Prince William Sound, and the lower Susitna. This general province contains valuable mineral deposits, chiefly gold, copper, and coal, as well as good farming lands, and its rapid development led to the search for water powers, which had been supposed to exist in abundance in this region. Water-Supply Paper 372 shows, however, that water powers available throughout the year are not so abundant in this part of Alaska as had been assumed. Appended to the main report is a reprint of an article on the water powers of southeastern Alaska which appeared in 1910 as part of Bulletin 442, "Mineral resources of Alaska, 1909." The illustrations include maps of parts of the region discussed, showing the location of rainfall stations, gaging stations, and measuring points, diagrams showing monthly and annual precipitation, and halftone plates showing hydrographic features.

WATER-SUPPLY PAPER 373. Water resources of Hawaii, 1913, by G. K. Larrison. 1915. 190 pages.

Contains results of measurements of the flow of certain streams and ditches and rainfall records in the Territory of Hawaii made during the calendar year 1913. Data for each gaging station are given under the following heads: Location, Records available, Drainage area, Gage, Control, Discharge measurements, Diversion, Accuracy, and Cooperation. Tables giving gage heights and daily and monthly discharges at each station are included in the report.

WATER-SUPPLY PAPER 374. Ground water in the Hartford, Stamford, Salisbury, Willimantic, and Saybrook areas, Conn., by H. E. Gregory and A. J. Ellis. 1916. 150 pages, 13 plates, 10 text figures.

Gives the results of a study of the ground-water supply of certain areas in Connecticut—a study which is so planned as to cover eventually all the towns of the State and to include investigations of stream flow as well as ground water. The work on which this paper is based consisted in gathering information concerning municipal water supplies, measuring the dug wells used in rural districts, obtaining data concerning drilled wells, driven wells, and springs, collecting and analyzing samples of water from wells, springs, and brooks, and studying the character and relations of bedrock and of surficial deposits with reference to their influence upon the ground-water supply. An individual description of each town is given, accompanied by a map of the area in which it is situated.

WATER-SUPPLY PAPER 375. Contributions to the hydrology of the United States, 1915; Nathan C. Grover, chief hydraulic engineer. 1916. 181 pages, 9 plates, 31 text figures.

This report is made up of seven short papers on ground water in certain arid sections of the United States and on methods of gaging river discharge. Issued first in the form of separate chapters, so as to furnish promptly information of the results of investigations made by the hydraulic engineers of the Geological Survey. A list of the papers included in the volume follows:

Ground water for irrigation in the Sacramento Valley, Cal., by Kirk Bryan.

Ground water in Paradise Valley, Ariz., by O. E. Meinzer and A. J. Ellis.

The relation of stream gaging to the science of hydraulics, by C. H. Pierce and R. W. Davenport.

Ground water in Big Smoky Valley, Nev., by O. E. Meinzer.

A method of correcting river discharge for a changing stage, by B. E. Jones.

Conditions requiring the use of automatic gages in obtaining records of stream flow, by C. H. Pierce.

Ground water in Lasalle and McMullen counties, Tex., by Alexander Deussen and R. B. Dole.

WATER-SUPPLY PAPER 376. Profile surveys in Chelan and Methow river basins, Wash., prepared under the direction of R. B. Marshall, chief geographer. 1915. 8 pages, 5 plates.

WATER-SUPPLY PAPER 377. Profile surveys in Spokane River basin, Wash., and John Day River basin, Oreg., prepared under the direction of R. B. Marshall, chief geographer. 1915. 7 pages, 9 plates.

WATER-SUPPLY PAPER 378. Profile surveys in 1914 on Middle Fork of Willamette River and White River, Oreg., prepared under the direction of R. B. Marshall, chief geographer. 1915. 8 pages, 6 plates.

WATER-SUPPLY PAPER 379. Profile surveys in 1914 in Umpqua River basin, Oreg., prepared under the direction of R. B. Marshall, chief geographer. 1915. 7 pages, 13 plates.

These reports describe briefly the general features of the river basins mentioned in their titles and give a list of the gaging stations maintained by the Geological Survey on the main streams and their tributaries. The illustrations consist of plans and profiles of certain of the streams described or parts of them.

WATER-SUPPLY PAPER 383. Surface water supply of the United States, 1914. Part III, Ohio River basin; N. C. Grover, chief hydraulic engineer; A. H. Horton and W. E. Hall, district engineers. 1916. 121+xxxii pages, 2 plates.

WATER-SUPPLY PAPER 385. Surface water supply of the United States, 1914. Part V, Hudson Bay and upper Mississippi River basins; N. C. Grover, chief hydraulic engineer; W. G. Hoyt and A. H. Horton, district engineers. 1915. 246+xxix pages, 2 plates.

WATER-SUPPLY PAPER 388. Surface water supply of the United States, 1914, Part VIII, Western Gulf of Mexico basins; N. C. Grover, chief hydraulic engineer; G. A. Gray, district engineer. 1915. 124+xxi pages, 2 plates.

These papers present briefly the results of measurements of stream flow in the basins named in the titles during the calendar year 1914. Data for each gaging station are given under the following heads: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Artificial control, Winter flow, Accuracy, and Cooperation. Contain also tables giving gage heights and daily and monthly discharges at each station and halftone plates representing typical gaging stations and current meters. At the end of each book is a list of all gaging stations maintained in the region covered and an annotated list of publications issued by the United States Geological Survey relating specifically to the region, as well as a similar list of reports that are of general interest, covering a wide range of hydrologic subjects, and brief references to reports published by State and other organizations.

WATER-SUPPLY PAPER 397. Ground water in the Waterbury area, Conn., by A. J. Ellis, under the direction of H. E. Gregory. 1916. 73 pages, 4 plates, 10 text figures.

Discusses the source, occurrence, use, and methods of developing the ground-water supplies of an area of about 171 square miles in Connecticut, including Waterbury and several other manufacturing towns, whose industries are largely dependent upon water power. An individual description of each town in the area is given, and especial stress is laid on its water supply. The illustrations include a map of the area discussed, and diagrams, sections, and halftone plates showing hydrographic features.

WATER-SUPPLY PAPER 398. Ground water in San Joaquin Valley, Cal., by W. C. Mendenhall, R. B. Dole, and Herman Stabler. 1916. 310 pages, 5 plates, 4 text figures.

Discusses the occurrence, quality, accessibility, character, and proper use of the ground waters of San Joaquin Valley, an area destined to become one of the chief agricultural districts of the West. The development of this valley is controlled by the distribution of rainfall, the character of the soils, and the possibility of applying other water than that which reaches the valley as a direct result of precipitation upon its surface, so that it behooves the inhabitants to avail themselves of every opportunity to increase the acreage of the lands under irrigation. An individual discussion of the water supply of each county in the valley is given, accompanied by tables of field assays and mineral analyses of its ground waters. The illustrations include maps of the valley showing artesian areas, ground-water levels, pumping plants, and location and depth of wells in relation to sulphate content of ground waters and cross sections and diagrams showing content of sulphate and total mineral matter of ground waters in certain parts of the valley.

WATER-SUPPLY PAPER 399. Geology and ground waters of northeastern Arkansas, by L. W. Stephenson and A. F. Crider, with a discussion of the chemical character of the waters, by R. B. Dole. 1916. 315 pages, 11 plates, 4 text figures.

Discusses the physiography, geology, and ground waters of the region mentioned in its title, embracing about 13,250 square miles and forming part of that great arm of the Gulf Coastal Plain known as the Mississippi embayment. Although this region is abundantly supplied with surface streams the water from them is unfit for domestic use without filtration, but the underground supplies require no purification and are therefore less expensive. The paper gives a detailed description of the water resources of each county in the region discussed and includes a chapter on the chemical character of these waters and methods of purification of water in general. The illustrations include a geologic map and a map of the ground-water resources of eastern and northeastern Arkansas, geologic sections, and halftone plates showing some of the water-bearing formations.

WATER-SUPPLY PAPER 400-A. The people's interest in water-power resources, by G. O. Smith. 1916. Pp. 1-8.

Part of Water-Supply Paper 400, "Contributions to the hydrology of the United States, 1916." This paper was read before the Second Pan-American Scientific Congress, Washington, December, 1915. It shows that in the vast potential hydroelectric energy available in the United States, estimated now at over 60,000,000 horsepower, lies this country's largest asset in the future industrial rivalry among nations, and advocates such Government regulation—Federal, State, and municipal—of the development of water power that both the public and the private owner and operator may participate in the benefits.

MINERAL RESOURCES OF THE UNITED STATES, 1914. 1916. Part I, Metals; H. D. McCaskey, geologist in charge; iv+*73+995 pages, 1 plate, 8 text figures. Part II, Nonmetals; E. F. Burchard, geologist in charge; iv+1,122 pages, 5 plates, 11 text figures.

Statistics of the production, importation, and exportation of mineral substances in the United States, including accounts of the chief features of mining progress, comparisons of past and present production and conditions, and the application of the products in the useful arts. Contains inserts showing mineral products of the United States, 1905-1914, and production of coal in the United States, 1807-1914. Issued first, as received, in 61 advance chapters, each covering a single mineral product or group of allied products.

MINERAL RESOURCES OF THE UNITED STATES, 1915. Thirteen advance chapters, as follows:

The public interest in mineral resources, by G. O. Smith. 1915. Pp. 1a-9a. Part I: A.

Chromic iron ore in 1915, by J. S. Diller. 1916. Pp. 1-6. Part I: 1.

Gold, silver, copper, lead, and zinc in the Eastern States in 1915 (mines report), by J. M. Hill. 1916. Pp. i-v, 7-20. Part I: 2.

Fuel briquetting in 1915, by C. E. Lesher. 1916. Pp. i-ii, 1-6, figs. 1-4. Part II: 1.

Sand-lime brick in 1915, by Jefferson Middleton. 1916. Pp. 7-8. Part II: 2.

Fuller's earth in 1915, by Jefferson Middleton. 1916. Pp. 9-12. Part II: 3.

Asbestos in 1915, by J. S. Diller. 1916. Pp. i-ii, 13-18, fig. 5. Part II: 4.

Slate in 1915, by G. F. Loughlin. 1916. Pp. 19-31. Part II: 5.

Fluorspar in 1915, with a note on cryolite, by E. F. Burchard. 1916. Pp. i-ii, 33-41, fig. 6. Part II: 6.

Feldspar in 1915, by F. J. Katz. 1916. Pp. 43-53. Part II: 7.

Silica in 1915, by F. J. Katz. 1916. Pp. 55-60. Part II: 8.

Abrasive materials in 1915, by F. J. Katz. 1916. Pp. 65-80. Part II: 10.

Graphite in 1915, by E. S. Bastin. 1916. Pp. 81-93. Part II: 11.

GEOLOGIC FOLIO 196. Philipsburg (Mont.) folio, by F. C. Calkins and W. H. Emmons. 1915. 25 folio pages of text, 3 maps, 1 columnar-section sheet, 12 plates, 9 text figures.

Description and maps of the Philipsburg quadrangle, comprising about 827 square miles in Deer Lodge, Granite, and Powell counties, Mont.

Geologic Folio 197. Columbus (Ohio) folio, by G. D. Hubbard, C. R. Stauffer, J. A. Bownocker, C. S. Prosser, and E. R. Cumings. 1915. 15 folio pages of text, 3 maps, 2 sheets of half-tone illustrations, 10 text figures. Published also in octavo form, 111 pp.

Description and maps of the Columbus quadrangle, comprising about 915 square miles in Delaware, Fairfield, Franklin, Licking, Madison, Pickaway, and Union counties, Ohio.

Geologic Folio 198. Castle Rock (Colo.) folio, by G. B. Richardson. 1915. 13 folio pages of text, 3 maps, 1 columnar-section sheet, 20 plates, 6 text figures.

Description and maps of the Castle Rock quadrangle, comprising about 925 square miles in Douglas, El Paso, and Elbert counties, Colo.

Geologic Folio 199. Silver City (N. Mex.) folio, by Sidney Paige. 1916. 19 folio pages of text, 2 maps, 1 structure-section sheet, 13 plates, 17 text figures.

Description and maps of the Silver City quadrangle, comprising about 1,003 square miles in Grant and Luna counties, N. Mex.

Geologic Folio 200. Galena-Elizabeth (Ill.-Iowa) folio, by E. W. Shaw and A. C. Trowbridge. 1916. 13 folio pages of text, 4 maps, 13 plates, 9 text figures.

Description and maps of the Galena and Elizabeth quadrangles, comprising about 442 square miles in Jo Daviess County, Ill., and Dubuque and Jackson counties, Iowa.

Geologic Folio 201. Minneapolis-St. Paul folio, by F. W. Sardeson. 1916. 14 folio pages of text, 8 maps, 22 plates, 14 text figures.

Description and maps of the Anoka, Minneapolis, St. Paul, and White Bear quadrangles, comprising about 846 square miles in Anoka, South Dakota, Hennepin, Ramsey, Scott, and Washington counties, Minn.

Topographic and other maps as follows:

Aitkin, Minn.
Alabama (State).[1]
Alaska (1 : 12,000,000).
Albany, Oreg.
Alger, Ohio.
Arlington, Oreg.-Wash.
Avon, Ill.
Babel Slough, Cal.
Bachelor Valley, Cal.
Belhaven, N. C.
Bellefontaine, Ohio.
Bering River coal field, Alaska.[2]
Big Bar and vicinity, Cal.
Bluefield, W. Va.[3]
Blue Mesa, Wyo.
Boone, Iowa.
Brilliant, N. Mex.-Colo.
Brinkhaven, Ohio.
Bucu, Va.
Bucyrus, Ohio.
Buffalo Creek, Cal.[3]
Byron, Cal.
Byron Hot Springs, Cal.[3]
Cache Slough, Cal.
Casco Bay, Me.[4]
Chateaugay, N. Y.
Concord, Cal.[5]
Cooperstown, Cal.
Cornettsville, Ky.
Craig, Colo.
Crestline, Ohio.
Cuyuna, Minn.
Deming, N. Mex.[5]
Dixon, Cal.
Eagle Rock, Va.
East Liberty, Ohio.
Edgington, Ill.-Iowa.
Ely, Nev.[5]
Esparto, Cal.[3]
Estacada, Oreg.
Fairfax, Va.
Falls City, Nebr.
Foraker, Okla.-Kans.
Frazer, Mont.
Freedom, Idaho-Wyo.
Gastonia, N. C.
Georgia (State).[1]
Gouverneur, N. Y.
Grass Creek Basin, Wyo.
Grays Bend, Cal.
Greenup, Ohio-Ky.[3]
Hacker Valley, W. Va.
Hamakua, Hawaii.
Harold, Ky.
Harrington, Cal.[3]
Haywards, Cal.[5]
Hershey, Cal.
Honomu, Hawaii.
Howe, Nebr.
Iaeger, W. Va.-Ky.[6]
Illinois (State).[1]
Kenton, Ohio.

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[1] Photolithograph, 1 : 1,000,000.

[2] Plate V, Bull. 335, issued separately.

[3] Preliminary edition showing part of quadrangle.

[4] Resurveyed and reengraved.

[5] New edition, revised in field.

[6] Sheet completed; part engraved in 1912.

Kentucky (State).[1]
Kinston, N. C.
Kohala, Hawaii.
Lake Bonaparte, N. Y.
Larue, Ohio.
Lone Tree Valley, Cal.[3]
Lovdal, Cal.
Maine Prairie, Cal.
Manhattan and vicinity, Nev.
Mare Island, Cal.
Maricopa, Ariz.
Marseilles, Ill.[3]
Martinsburg, W. Va.-Va.-Md.
Maryland and Delaware (States).[1]
Maryland and Delaware (States).[4]
Massachusetts and Rhode Island contour map.[5]
Michigan (State).[1]
Midway, Cal.[2]
Millersburg, Ohio.
Mission, Tex.
Mojave, Cal.
Montpellier, Cal.
Mount Gilead, Ohio.
Murfeesboro, Tenn.
Neosho, Mo.
New York (State).[1]
Northeast, Pa.-N. Y.
Norwalk, Ohio.
Oakdale, Cal.
Ocosta, Wash.
Ohio (State).[1]
Oregon (State).[1]
Oswego, Mont.
Patterson, Cal.[3]
Paulsell, Cal.
Pearce, Ariz.
Pennsylvania and New Jersey (States).[1]
Peterstown, W. Va.-Va.[3]
Pickins, W. Va.
Point Conception (sheet I-10 of world map).
Portland, Me.[3]
Regina, Va.-Ky.[3]
Richwood, Ohio.
Ripon, Cal.
Romain, Cal.[2]
St. Albans, Vt.
St. Paris, Ohio.
Salida, Cal.
San Francisco, Cal.[6]
San Juan, Tex.
San Mateo, Cal.[6]
Saxon, Cal.
Searles Lake, Cal.
Shauck, Ohio.
Shawneetown, Ill.-Ky.
Siam, Ohio.
Soledad, Cal.
Stryker, Mont.
Somerset, Pa.
South Carolina (State).[1]
Spearfish, S. Dak.[6]
Spenceville, Cal.[2]
Sturgis, S. Dak.[6]
Summersville, W. Va.
Summitville, Colo.-N. Mex.
Tennessee (State).[1]
Thalheim, Cal.
Three Tree Flat, Cal.
Tracy, Cal.[2]
Trigo, Cal.
Tualatin, Oreg.
United States contour map 18 by 28 inches.[5]
Virginia (State).[1]
Vorden, Cal.
Waipio, Hawaii.
Waldoboro, Me.
Washington (State).[1]
Waynesville, Ohio.
Wealthwood, Minn.
Wellington, Utah.
Wenatchee, Wash.
Westley, Cal.
Westport, Cal.
West Virginia (State).[1]
Whitesburg, Ky.-Va.
Windber, Pa.
Winona, W. Va.
Winters, Cal.
Wolf Point, Mont.
Yosemite National Park, Cal.[6]
Zamora, Cal.[2]

GEOLOGIC BRANCH.

SCOPE OF WORK.

The geologic branch is responsible for the strictly geologic work of the Survey, which was originally established for "the classification of the public lands and the examination of the geological structure, mineral resources, and products of the national domain" and was later authorized "to continue the preparation of a geological map of the United States." In pursuance of these objects the Survey has been obliged to extend its operations to every part of the country and to nearly every field of geology. Its growth, however, has not kept pace with the growth of the mineral development which it has promoted. The calls for service made on it by the public were never before so numerous nor so varied.

The Survey has not only performed this fundamental and principal work but has gradually come to be regarded, in effect, as a national bureau of public information on geologic matters, touching not only all parts of the United States and Alaska but other countries as well. The marked increase in the number of inquiries received by the Survey is due not merely to the present abnormal activity in the mineral industries, but largely also to the growing tendency of the American people to apply to the Federal Survey for geologic information of every sort, whether this information is to be gained by new field work or by examination of the Survey's accumulated records and its great library. The geologic branch therefore has a double task, embracing on the one hand geologic surveying—including the investigation, description, and mapping of the geology and mineral deposits of all parts of the country and the classification of the public lands—and the publication of the results of its work, and on the other hand the furnishing to the public of miscellaneous geologic information derived from all available sources.

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[1] Photolithograph, 1 : 1,000,000.
[2] Preliminary edition showing part of quadrangle.
[3] Resurveyed and reengraved.
[4] Photolithograph, 1 : 500,000.
[5] New edition, office revision.
[6] New edition, revised in field.

ORGANIZATION.

For the systematic and efficient accomplishment of its work the geologic branch is organized in four divisions—geology, David White, chief geologist, in charge; Alaskan mineral resources, Alfred H. Brooks, geologist, in charge; mineral resources, H. D. McCaskey, geologist, in charge; chemical and physical researches, G. F. Becker, geologist, in charge. These divisions, though largely autonomous, are conducted in the closest cooperation, with resultant effectiveness as well as economy. Most of the statistical reports of the division of mineral resources are prepared by members of the division of geology who are specialists in the geology of the respective mineral deposits and whose field investigations give opportunities for close contact with and observation of the mineral industries. Between the division of Alaskan mineral resources and the division of geology there is free exchange of assistance in paleontologic and other laboratory investigations. The division of chemistry and physics cooperates with the members of the scientific staffs of all the other divisions in the solution of the chemical problems under investigation and performs the chemical determinations necessary to the routine work of the Survey. In the distribution and use of field equipment the geologic branch cooperates with the topographic and water-resources branches.

The geologic investigations to be carried on by the Survey in the United States are planned by the chiefs of sections in the division of geology in council with the chief geologist, who has general supervision of the work. The chief geologist has given particular attention to cooperation in geology with State surveys and devotes such time as is available to him for field work to field inspections and conferences with chiefs of sections and geologists and to the direction and inspection of the work of the section of eastern fuels.

PUBLICATIONS.

The publications of the fiscal year 1916 prepared wholly or partl in the geologic branch embrace 1 monograph, 31 professional paper bulletins, etc., 127 chapters of reports later published as annual vo umes, and 6 geologic folios. Titles and brief abstracts of the publications are given on pages 19–37. Besides the official public tions, 61 papers were, with the permission of the Director, publish in scientific journals and in the publications of scientific societi Nine reports based on work done in cooperation with State ge logical surveys have, in accordance with the cooperative agreemen been transmitted to the States for publication. On the other han two somewhat extensive geologic reports, prepared by the State o ganizations under the same agreements, have been submitted f publication by the Federal Survey, and others are in preparati by the States. In the preparation of the reports of mineral prod tion considerable material relating to certain of the industries in t different States is compiled by the State geologists.

PROGRESS OF GEOLOGIC MAPPING.

The areas in the United States covered by geologic maps publis by the Survey and the general nature of the work in each area shown on Plate I. This map does not, however, indicate areas which reports, prepared by this Survey, have been submitted publication to cooperating State organizations or to other bure and departments of the Federal Government.

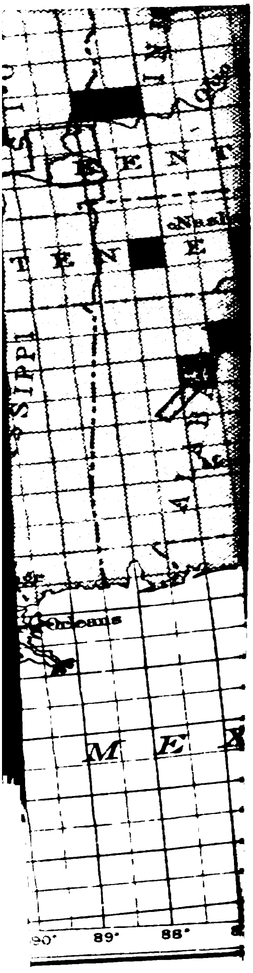
The progress of geologic surveying in Alaska is described in sction on the division of Alaskan mineral resources (pp. 91–99).

DIVISION OF GEOLOGY.

ORGANIZATION.

The scientific force of the division of geology at the beginning the year consisted of 70 geologists, 28 associate geologists, 33 assi ant geologists, 9 junior geologists, and 24 geologic aids. During t year 10 members of the scientific staff resigned to take positions private life at higher salaries, one new member was appointed, an one was transferred from another division. The total number o geologists of various grades on the staff at the end of the year wa 156. Of this number, 80 were employed continuously, 33 gave only part of their time to Survey work, and 43 were not employed.

The division of geology was organized in nine sections, the scope of whose work is outlined on pages 44–48. Near the end of the year the division was reorganized, and beginning July 1, 1916, its work will be distributed among ten sections, as stated on pages 48–49.



PUBLISH

The geologic work of the division, both in the field and in the office, is under the immediate supervision of the chiefs of the respective sections, who are directly responsible for maintaining efficiency and a high scientific standard. Exceptions are made of the studies of detrital deposition in California, just completed by G. K. Gilbert, the general descriptions by Mr. Gilbert of the structure in the Great Basin region, and the general monographic treatment of the geology of the Yellowstone National Park, in preparation by Arnold Hague. The work of these distinguished senior geologists of the Survey is reported directly to the chief geologist.

ALLOTMENTS.

The total funds available for the geologic work of the Survey in the United States for the year 1915–16 were as follows:

Geologic surveys	$350,000
Statutory salaries	13,700
Search for potash deposits (part of the appropriation for chemical and physical researches)	16,150
	379,850

The allotments of the appropriations were as follows:

Section of eastern areal geology	$20,025
Section of western areal geology	28,520
Section of Coastal Plain investigations	13,525
Section of stratigraphy and paleontology	20,040
Section of metalliferous deposits	42,245
Section of nonmetalliferous deposits (including potash)	36,640
Section of glacial geology	6,015
Section of eastern fuels	29,175
Section of western fuels	50,000
Geologic-map editing	7,020
Débris investigation and inspection	3,900
Supervision, administration, salaries of clerical, technical, and skilled-labor forces, instruments, supplies, and contingent fund	93,025
	350,130
Land-classification board	29,720
	379,850

Of the amounts allotted to this division, approximately $263,700 was expended directly for geologic work, including the search for potash. Of this amount, about $165,800, or 62.8 per cent, was expended west of the one hundredth meridian, and $97,900, or 37.2 per cent, east of the one hundredth meridian. If, however, the $29,720 for the operations of the land-classification board is included, 66.6 per cent of a total approximating $293,420 was spent for investigations west of the one hundredth meridian—that is, essentially in the public-land States. The allotment for supervision, etc., is divisible in very nearly the same proportion between the eastern and western work.

COOPERATION WITH FEDERAL BUREAUS AND STATE SURVEYS.

In strictly geologic field investigations or paleontologic studies the Survey cooperated through the division of geology with 19 States—Alabama, Georgia, Illinois, Iowa, Kentucky, Maryland, Michigan, Minnesota, Mississippi, Missouri, New Jersey, North Carolina, Oklahoma, Oregon, Pennsylvania, Tennessee, Texas, Virginia, and Wisconsin. Informal cooperation, without specific financial obligations, exists between most of the other States having geological surveys.

The Survey cooperated with the Bureau of Mines in the metallographic study of ores, in the investigation of the invasion of California oil wells by salt water, in studies of the application of geology to engineering problems of mining and construction, and in the examination of placers and placer mining in the United States. Technologic papers prepared by Survey geologists in the course of their detailed investigations of mineral deposits have been submitted to the Bureau of Mines for publication. The Survey is also engaged with the Bureau of Standards, the Bureau of Mines, and the Office of Public Roads in a thorough and systematic study of the building stones of the United States. Through the division of geology it cooperated informally with the Smithsonian Institution, the Bureau of Fisheries, the Forest Service, the Navy Department, the War Department, and the Lighthouse Service, as well as with a number of institutions of learning, including, in particular, the Geophysical Laboratory and Marine Biological Station of the Carnegie Institution. Services varying in extent have been rendered during the year to the Department ofAgriculture in the examination of lands in the national forests and monuments; to the Department of Justice in connection with its suits regarding public lands; to the Navy Department in regard to oil and water supplies; to the Office of Indian Affairs in the classification of Indian lands; to the War Department with reference to nitrate deposits and to water supplies in its reservations; and, most important of all, to the General Land Office in the classification of withdrawn coal, oil, and phosphate lands.

GENERAL FEATURES OF THE WORK OF THE YEAR.

The highly diverse services rendered by the geologic branch were fully outlined in the reports for the last two years.[1] All phases of the work have been continued, though on account of a reduction of $50,000 in the appropriation it has been necessary to refuse requests for field examinations in greater number than ever before. To some extent, however, the lack of money for the expenses of field investigations and for pay of young assistants has been compensated by the greater capacity and scientific productivity developed in the staff with growing experience, knowledge, and maturity. Nevertheless, an increase in the funds sufficient to provide salaries and field expenses of geologic aids to serve under the direction of the older geologists would yield more than proportionate benefits in the extension of the work, the fuller response to the public demands, and the more economical utilization of the directive knowledge and experience of the older and higher-salaried men.

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[1] U. S. Geol. Survey Thirty-fifth Ann. Rept., pp. 34–36, 71–74, 1914; Thirty-sixth Ann. Rept., pp. 42–50, 1915.

As usual, greater attention has been given to the geologic examination and classification of the lands and to special study of the mineral deposits in the public-land States than to any other investigation or region. Accounts of this work are given under the respective State headings (pp. 51-91).

In the last annual report reference was made to studies by the Survey of the chemical character of the waters at different depths in the California oil fields, and of the change in these waters near accumulations of oil. The results of these studies, a preliminary report on which will soon be issued as Bulletin 653, give reason for the expectation that, in this region at least, great assistance in the search for oil may be derived from observations of the chemical characteristics of the waters. These observations will be checked by field work and tests in areas that present different climatic and other physical conditions.

A large map showing the coal fields of the United States and indicating the general rank of the coals, prepared to accompany a general summary description of the coals of the country and their qualities, is now in press for publication as the first part of Professional Paper 100, "The coal fields of the United States." More detailed reports covering the coal fields of several States are now prepared, and others are in preparation or planned, to be in due time issued as parts of this professional paper.

Some results of the studies of the ores from certain of the western metal-mining districts by use of the metallographic microscope, to which reference was made last year, are now being prepared for publication in a paper entitled "Studies of the genesis of some ores at Tonopah, Nev." The joint geologic and chemical studies of silver enrichment are continuing, with promise of still more results of high value.

The economic geologic investigations of broad geographic scope now in progress include examinations of the marbles in the Appalachian States and the limestones in the Central States, the accumulation of data for a descriptive catalogue of the building stones of the United States, and studies of the phosphate resources of Kentucky and Tennessee and of the tungsten, mica, graphite, and gypsum deposits of the United States. Papers on the conservation of the phosphate deposits, giving new estimates of the phosphate resources of the country, have been published through unofficial channels.

The deciphering of the later chapters in the geologic history of the Gulf region of the United States, and in particular an understanding of the mutual relations of the Antillean region of the Gulf coast of Central America and South America, have been very much furthered by a number of contributions made by members and associates of the section of Coastal Plain investigations in several publications, both official and unofficial, which are noted in the detailed account of the work of the division by States. A general report by Mr. MacDonald on the geology of the Canal Zone region is near completion.

Among the reports completed that should be of unusual interest to the mining public may be mentioned the comprehensive description of the Tintic district, Utah, with maps, by Messrs. Lindgren and Loughlin, and a general report on the mining districts of Utah, by Mr. Butler.

So great was the demand for the first edition of the bulletin on the useful minerals of the United States that a revised and much enlarged edition has been prepared. This is now in press as Bulletin 624.

Three guidebooks to the western United States, Bulletins 611, 613, and 614, prepared mainly during the preceding year, were published. Another one, descriptive of the country along the Denver & Rio Grande Route from Denver to Salt Lake, is now in preparation. These books, which are designed for the use of travelers and are written in popular and educational style, deal not only with the geology but with the natural resources, history, and development of the country traversed.

SCOPE OF THE WORK OF THE SECTIONS.

The work of the several sections of the division of geology is briefly outlined in the following synopsis:

1. The section of eastern areal geology—Arthur Keith, geologist, in charge—conducts reconnaissance and detailed work in areal or general geology in regions east of the one hundredth meridian, the primary object of which is to make known, mainly through folios of the Geologic Atlas, the general geology of the regions studied, or to prepare scientific and educational descriptions of them. Papers de-

scribing the more important of the mineral deposits of the areas thus examined may be prepared for publication in advance in the economic bulletins. The work of this section is carried on in close cooperation with several State surveys and university departments of geology, an effort being made to coordinate the work of all participants. During the year the operations of the section have covered areas in Alabama, Arkansas, Delaware, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Vermont, and Virginia.

2. The work of the section of western areal geology (west of the one-hundredth meridian)—F. L. Ransome, geologist, in charge—corresponds to that of the section of eastern areal geology and is similar in scope, these sections being especially charged with the preparation of the folios of the Geologic Atlas of the United States. The work of this section has included areal mapping and descriptions of areal geology in Arizona, Colorado, Idaho, Montana, Nebraska, New Mexico, Oregon, South Dakota, Washington, and Wyoming.

3. The section of Coastal Plain investigations—T. W. Vaughan, geologist, in charge—is occupied with the study of the geology of the Atlantic and Gulf Coastal Plain of the United States in the broadest practicable way. Special attention is given to studies that will aid in understanding the geologic history of the province, including investigations of the physiology, stratigraphy, geologic structure, paleontology, and origin of the different kinds of sediments. Knowledge thus acquired furnishes a scientific foundation for the investigation of geologic resources of many kinds. In the study of economic resources particular consideration is given to ground waters, which are of inestimable value in the conservation of public health, and a preliminary survey of this resource has now been almost completed for the entire province.

The paleontologic work of the section is of fundamental importance, as only by detailed and accurate knowledge of the organisms occurring in and characterizing the geologic formations and their subordinate members can the time equivalents of beds in one area be recognized in another. This knowledge also aids in recognizing beds that are penetrated by well borings if fossils should occur in the material brought up by the drill.

During the year a preliminary geologic map of the Coastal Plain was drawn on a scale of 1:1,000,000, embracing an area of 450,000 square miles. The reconnaissance mapping of the area, except the State of South Carolina and about 13,000 square miles adjacent to the Rio Grande in Texas, has been completed. The two deficiencies mentioned will be filled as soon as possible—it is hoped within the coming fiscal year.

Much attention has been paid by members of the section to sediments now being laid down in the sea, because of their bearing on the interpretation of the conditions under which sediments exposed on the land surface and encountered in well borings were deposited.

The National Museum, the Bureau of Fisheries, the Carnegie Institution, the Bureau of Soils, the Bureau of Lighthouses, the Bureau of Plant Industry, and a number of specialists in biology or paleontology, as well as the division of underground waters of the water-resources branch, have cooperated with or contributed to the work of this section.

Investigations have been carried on by this section during the year in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, North Carolina, Rhode Island, South Carolina, Tennessee, Texas, and Virginia.

4. The section of glacial geology—W. C. Alden, geologist, in charge—is engaged in the study of the work of glaciers, the glacial and interglacial deposits and the contemporary deposits of the bordering regions, and the geologic history of the continent during the Quaternary period. The geologists occupied with these varied and specialized problems are charged with the classification and mapping of the Quaternary deposits of the glaciated regions. The work of this section during the year has comprised field studies and mapping and the preparation of reports covering areas in California, Illinois, Iowa, Maine, Massachusetts, Michigan, Minnesota, Montana, New York, New Jersey, North Dakota, Pennsylvania, Vermont, and Wisconsin.

5. The section of paleontology and stratigraphy—T. W. Stanton, geologist, in charge—is responsible for the determination of the relative age and equivalence of the strata in different areas and for the reference of the formations to a geologic time scale. The collections of fossils sent in by field geologists for examination and those obtained by the paleontologists themselves in the course of special field investigations have equaled those of previous years in size and importance. Their identification and the preparation of preliminary reports on them form a considerable part of the paleontologists' work, the results of which are embodied in many of the economic and stratigraphic reports of the Survey and add greatly to their accuracy and value. Reports on current collections of vertebrate fossils have been furnished by the United States National Museum.

The work of this section is practically coextensive with that of the divisions of geology and of Alaskan mineral resources and is indispensable to the geologic mapping of the areas surveyed and the satisfactory determination of the structure. It touches nearly all the States.

6. The section of the geology of metalliferous deposits—F. L. Ransome, geologist, in charge—not only studies metalliferous deposits and mines and investigates the conditions and modes of ore deposition but also carries on reconnaissance geologic examinations of many new districts and makes complete detailed areal surveys, for folio publication, of quadrangles in which metalliferous deposits are of especial importance, the folios being subject to the inspection and approval of the geologists in charge of areal geology. Several geologists in this section have prepared, for publication in Mineral Resources of the United States, statistical reports on the production of metals or minerals with which they are specially conversant and statements on the industrial conditions relating to them. The work of the section has embraced the investigation of metalliferous deposits in Alabama, Arizona, California, Colorado, Georgia, Idaho, Kansas, Louisiana, Maryland, Minnesota, Missouri, Montana, Nevada, New Mexico, Oklahoma, Oregon, Tennessee, Texas, Utah, Virginia, Washington, and Wyoming.

7. The section of the geology of nonmetalliferous deposits—H. S. Gale, geologist, in charge—is concerned with the study of the deposits of nonmetallic ores and minerals, exclusive of fuels, and with the geologic investigation and mapping of regions in which such minerals or deposits are of paramount importance. During the year the greater part of the work of the section has consisted in large part of the search for potash in commercial quantities in the salts of old evaporation basins or dried-up ancient lakes of the Great Basin region and in the Permo-Triassic "Red Beds" of New Mexico and Texas. These investigations are more fully described on pages 11–14. With them has been combined a diligent search for nitrates.

The classification of the phosphate-bearing lands in Idaho, Montana, and Wyoming withdrawn from entry has also been carried forward. Special investigations relating to clays, building stones, and the eastern phosphate fields have been made, and field and office work in the preparation of general bulletins on the graphite, mica, and gypsum deposits of the United States have been in progress. The work in the section has involved field investigations or laboratory studies relating to nearly every State.

8. The section of eastern fuels—David White, chief geologist, in charge—conducts examinations of areas east of the one-hundredth meridian that contain coal, oil, or gas. It not only investigates and describes the economic geology but in some regions also works out the detailed areal geology for folio publication, the folios being subject to the inspection and approval of the geologist in charge of the section of eastern areal geology. In this section special attention has been given to the discovery and mapping of structure favorable to the occurrence of oil and gas in undeveloped regions which may later produce oil.

The work of the section during the year has been done in cooperation with the State surveys of Illinois, Kentucky, Missouri, Oklahoma, Pennsylvania, Tennessee, and Virginia. Noncooperative work has been done in Kansas, Louisiana, Mississippi, Ohio, Texas, and West Virginia.

9. The section of western fuels—M. R. Campbell, geologist, in charge—conducts examinations and surveys in the fuel-bearing regions west of the one-hundredth meridian, similar to those made by the section of eastern fuels. The greater part of the work of the western section has consisted in classifying and mapping coal or oil bearing lands of the public domain in California, Colorado, Montana, New Mexico, Utah, and Wyoming, but the section has also carried on detailed mapping of the geology in quadrangle units for folio publication, subject to the approval of the geologist in charge of the section of western areal geology. Several members, including the chief of this section, serve as members of the coal and oil committees in the land-classification board.

Broad researches of general interest in progress in this section include studies of the mutual chemical relations of water and oil in oil fields and of the utilization of the hydrocarbon shales of Colorado and Utah as sources of petroleum and other distillation products, also the preparation of a general report on the coal fields of the United States.

The section of geologic-map editing—G. W. Stose, geologist, in charge—is a part of the publication branch, but its work is so intimately associated with the work of the individual geologists in the division of geology that it is administered as a part of the geologic branch, in which the chief of the section is an active geologist. The geologic field investigations made by Mr. Stose are reported in the sections to which they pertain. The office work of this section is described on pages 166–167.

To lessen the administrative work of the geologist in charge of western areal geology and the geology of metalliferous deposits and of the geologist in charge of western fuels, and thereby to increase their opportunities for scientific work, the sections of the division of geology were, in June, 1916, reorganized as follows, to take effect July 1:

1. Section of eastern areal geology. Arthur Keith, geologist, in charge.
2. Section of western areal geology. Sidney Paige, geologist, in charge.
3. Section of the geology of metalliferous deposits. F. L. Ransome, geologist, in charge.
4. Section of the geology of nonmetalliferous deposits. H. S. Gale, geologist, in charge.
5. Section of Coastal Plain investigations. T. W. Vaughan, geologist, in charge.
6. Section of glacial geology. W. C. Alden, geologist, in charge.

7. Section of paleontology and stratigraphy. T. W. Stanton, geologist, in charge.
8. Section of the geology of western coal fields. M. R. Campbell, geologist, in charge.
9. Section of the geology of eastern coal fields. G. H. Ashley, geologist, in charge.
10. Section of the geology of oil and gas fields. David White, chief geologist, in charge.

The subsection of investigations in petrology, in charge of E. S. Larsen, jr., is to be attached to the section of the geology of metalliferous deposits.

ASSISTANCE TO OTHER DIVISIONS.

In addition to performing work in their respective sections, a considerable number of the geologists in the sections of metalliferous and nonmetalliferous deposits and several geologists in the sections of eastern and western areal geology have prepared for publication, in the annual volumes of Mineral Resources, reports on the production and statements of the industrial conditions relating to a large number of mineral resources with which they are especially familiar. Parts of the salaries of some of these geologists are paid from the funds of the division of mineral resources, and the traveling and field expenses incurred by others in the collection of data are also paid from the funds of that division.

A number of economic geologists of this division serve as members of the special committees of the land-classification board. The paleontologists of the division report on fossils collected for the division of Alaskan mineral resources and are called upon to classify fossils for the National Museum and, through courtesy, occasionally for foreign Governments and other scientific institutions.

Close cooperation, with constant interchange of information, exists between the geologic branch and the water-resources branch in the investigation of underground-water movements and supplies and of sedimentary deposition. Members of the land-classification board serve in the geologic field parties.

COMMITTEE ON GEOLOGIC NAMES.

The committee on geologic names, a standing committee of the geologic branch, was reorganized on December 1, 1915, and now consists of T. W. Stanton (chairman), G. W. Stose, W. T. Lee, Sidney Paige, and L. W. Stephenson. The chiefs of section in the division of geology and the chief of the division of Alaskan mineral resources also serve as associate members, each of whom is invited to attend meetings at which matters pertaining to his section or division are under consideration. Authors of manuscripts under discussion are expected to be present or to select someone to submit their views. On each question the individual opinions of the persons present are recorded and forwarded to the chief geologist, who makes the decision, subject to appeal to the Director. The records are kept by the secretary, Miss M. G. Wilmarth, who also examines all manuscripts submitted for publication and compares the geologic nomenclature and classification used in them with the standards in current use by the Geological Survey. During the year 153 manuscripts, comprising 15,200 pages and involving about 3,150 geologic names, have been examined. Good progress has been made in preparing the manuscript of a stratigraphic lexicon of geologic formations, mentioned in the report for last year, and some preliminary work has been done toward compiling general correlation charts.

COMMITTEE ON PHYSIOGRAPHY.

The committee on physiography was, on March 1, 1916, reorganized, with changes both in the scope of its work and in its personnel. The reorganized committee consisted of M. R. Campbell (chairman), Laurence LaForge, F. E. Matthes, E. W. Shaw, and P. S. Smith. At his request Mr. LaForge was relieved from service with the committee, and in June, by arrangement with the chief hydraulic engineer, O. E. Meinzer, of the water-resources branch, was appointed in his place.

The duties of this committee are as follows:

1. To read critically and give advice as to physiographic papers or physiographic chapters or sections in other papers submitted for publication by the Survey.
2. To consider the classification and nomenclature of physiographic provinces.
3. To prepare or make recommendations as to the preparation of physiographic descriptions in popular language, to be printed on the backs of topographic sheets.
4. To consult with geologists regarding the solution of physiographic problems.
5. To formulate the usage of physiographic terms, in continuance of the work of the old committee.
6. To confer with the chiefs of sections and with the chief geologist regarding physiographic work to be undertaken by the Geological Survey.

After considering for some time certain general principles of physiography, the committee entered upon a joint consideration. with a committee appointed by the Association of American Geographers, of a standard scheme of physiographic divisions in the United States. The work previously in progress in the committee of the association was completed in cooperative conferences, and the joint findings were approved and arranged for publication.

The committee has taken up the question of more exact definition of physiographic terms and, through conferential discussion with the leading physiographers of the country, it aims at greater uniformity and cooperation among American physiographers, both in the use of terms and in physiographic classification.

GENERAL SUMMARY OF GEOLOGIC WORK.

Geologic investigations were continued in 47 States, the Canal Zone, and the West Indies. Systematic detailed surveys in metal-mining districts were carried on in California, Minnesota, Nevada, New Mexico, and Utah, and reconnaissance studies of metal-mining districts were made in Alabama, Idaho, Maryland, Montana, Nevada, New Mexico, Utah, and Virginia. Potash and nitrate prospects were investigated in the States containing semiarid regions, in the "Red Beds" region of the Southwest, and through the analytical testing of brines coming from many oil, water, and salt wells in other portions of the country. Other nonmetalliferous deposits of one kind or another were examined in nearly every State. Coal fields were investigated in Colorado, Idaho, Kentucky, Montana, New Mexico, Ohio, Pennsylvania, Tennessee, Utah, Virginia, and Wyoming; and studies with mapping of oil and gas structures were made in California, Colorado, Illinois, Indiana, Kentucky, Louisiana, Mississippi, Montana, New Mexico, Ohio, Oklahoma, Pennsylvania, Texas, Virginia, and Wyoming. Reports describing mineral deposits previously examined in other States and not mentioned above are now in preparation. General and detailed geologic and paleontologic work was continued in all parts of the country, including a large amount of geologic work in connection with the examination of the economic resources just mentioned. Work in classifying lands of the public domain and of Indian reservations was carried on in Arizona, California, Colorado, Idaho, Montana, New Mexico, North Dakota, Oregon, Utah, Washington, and Wyoming.

WORK OF THE DIVISION BY STATES.

ALABAMA.

The important graphite deposits in Clay County, Ala., were examined by E. S. Bastin in June, and a brief description was immediately given to the press. The detailed description of the deposits will appear in Mr. Bastin's general report on the graphite deposits of the country.

A report on the red iron-ore beds in northeastern Alabama has been completed by Mr. Burchard and will be included in a bulletin on the red iron ores of northeastern Alabama, eastern Tennessee, and northwestern Georgia.

The texts for the Bessemer-Vandiver and Montevallo-Columbiana folios, by Charles Butts, have been completed and are in preparation for publication.

Collections of Tertiary fossils from the State were identified and the preparation of a report on the stratigraphy and correlation of the Jackson and Vicksburg groups was begun by C. W. Cooke. Reports on the fossil floras of the Jackson and Claiborne groups, by E. W. Berry, and on the orbitoid and nummulitid Foraminifera, by J. A. Cushman, have been almost completed. Brief examinations of the terraces near Tuscaloosa and Mobile were made by E. W. Shaw and G. C. Matson. The age of the Ocala limestone is discussed in Professional Paper 95–I by C. W. Cooke; and the geologic history of a part of the Coastal Plain of the State is considered by E. W. Berry in Professional Paper 95–F. The older Tertiary Bryozoa are described in a paper by F. Canu and R. S. Bassler, almost completed.

Two reports by G. C. Matson and E. W. Berry, entitled "The Pliocene Citronelle formation of the Gulf Coastal Plain and its flora" (Professional Paper 98–L) and "The Catahoula sandstone and its flora" (Professional Paper 98–M), are in press.

ARIZONA.

The preparation of a professional paper on the copper deposits of the Ray and Miami districts has been continued, when other duties permitted, by F. L. Ransome. The work done contributes to some extent toward the preparation of the Ray folio, which Mr. Ransome also has in hand.

The geology and geography of the Navajo country are described by H. E. Gregory in a paper to be published as Professional Paper 93. This paper is based on an extended reconnaissance of parts of Arizona, New Mexico, and Utah.

Some Paleozoic sections in Arizona and their correlation are discussed in a paper by F. L. Ransome for publication as Professional Paper 98–K.

A report entitled "A reconnaissance of the Archean complex of the Grand Canyon," by L. F. Noble and J. F. Hunter, jr., is in press as Professional Paper 98–I. The field work on which this report was based was done in 1914 by Mr. Noble, partly at his own expense; the petrographic studies were made in 1915 by Mr. Hunter.

Progress was made by C. H. Clapp during the summer of 1915 in the mapping of the Winkelman quadrangle, although no funds could be allotted to him.

Reports on the production of asbestos, talc and soapstone, and chromic iron ore in the United States during 1915 have been prepared by J. S. Diller. Arizona now stands first in the production of high-grade asbestos.

ARKANSAS.

The coal fields of Arkansas are described in summary form, with analyses, by A. J. Collier in a manuscript which will appear as a chapter in Professional Paper 100, "The coal fields of the United States."

The geology of the Hot Springs quadrangle was briefly reviewed by H. D. Miser, in connection with the examination of the area covering Hot Springs and vicinity, for which a folio will soon be submitted for publication.

The geology and mineral deposits of the Caddo Gap quadrangle were further examined by Mr. Miser. The folio covering the Caddo Gap and De Queen quadrangles is near completion. A collection of plants from the Bingen sand in this region proved to be the first identifiable fossil plant material procured from the Upper Cretaceous of Arkansas.

A detailed geologic and topographic map of the principal area of diamond-bearing peridotite in Arkansas was also made by Mr. Miser.

In the northeastern part of the State additional investigations of the sunken lands were made for the Department of Justice by E. W. Shaw, and some valuable geologic results were obtained in the course of the work. A report on the floras of the Jackson and Claiborne groups has been nearly completed by E. W. Berry.

A report on the geology and ground waters of northeastern Arkansas, by L. W. Stephenson and A. F. Crider, has been published as Water-Supply Paper 399. Eocene erosion intervals are described by E. W. Berry in Professional Paper 95–F, and descriptive reports on the Chester and Pottsville faunas of Arkansas and Oklahoma are in preparation by G. H. Girty.

Papers by Mr. Girty on the invertebrate faunas of the Batesville sandstone, of the so-called Boone chert at Batesville, and of the Boone limestone at St. Joe have been printed as Bulletins 593, 595, and 598, respectively.

The greensands of Hempstead County were examined by G. H. Ashley and sampled for chemical analysis and study with special reference to their potash content. A report of the results of the analyses will soon be published.

CALIFORNIA.

The studies of hydraulic mining débris in the Sierra Nevada, Cal., carried on by G. K. Gilbert under the joint auspices of the geologic and water-resources branches, were continued and practically completed. Additional field work in the measurement of tidal currents in the summer and autumn of 1914 was supplemented by research in the archives of the Coast and Geodetic Survey, and information gained from these and from various other sources led not only to revision but to expansion, so that the report is now much more voluminous than it was originally, and three-fifths of it embodies either new material or old material with new treatment.

The investigation of the petroleum resources of California was continued by R. W. Pack, assisted by W. A. English. Mr. Pack, on account of the necessity for completing a report at an early date, was unable to take the field; but Mr. English, under Mr. Pack's direction, spent 3½ months in an examination of certain withdrawn lands in the Cholame and San Miguel quadrangles, for the purpose of classifying them as oil or nonoil lands and also of obtaining data for a report on the possibilities of finding oil. The area examined contains 970 square miles, 490 square miles of which was examined in detail and 480 square miles in a fairly detailed reconnaissance. The land has been classified, and Mr. English has submitted a report on the oil possibilities of the region.

Mr. Pack, in addition to supervising the work of Mr. English, has prepared a detailed report on the Sunset-Midway oil field, for the use of the experts of the Bureau of Mines, and has nearly completed a report on the same field for publication. Mr. Pack spent the last half of May and all of June in the field, gathering data for the completion of this report.

The study of the water problem in the Sunset-Midway and Coalinga oil fields, begun by G. S. Rogers in 1914, was continued by him in the summer of 1915. Mr. Rogers spent 3½ months in collecting well logs and in gathering data for a general study of the encroachment of water upon the productive territory in each of the fields and in a study of the effect of petroleum upon water and conversely of different waters upon petroleum. The results of the chemical studies are given in a manuscript submitted by Mr. Rogers for publication as Bulletin 653 of the Survey. The chemical examination of the water promises to be of great value in "wild-cat" operations, at least in regions of dry climate, as it seems to enable the driller to judge of the proximity of oil by the change in composition of the water, or of the probable absence of oil by the uniformity of composition of the water encountered in drilling.

A report on the geology and oil resources of the west border of the San Joaquin Valley, by Robert Anderson and R. W. Pack, has been published as Bulletin 603, and a short paper by W. A. English on the geology and oil prospects of Cuyama Valley as Bulletin 621-M.

A special survey of the work of the recent volcanic eruptions in the Lassen Peak region, embracing about 200 square miles, was made in 1915 by J. S. Diller, who is preparing an educational bulletin on this interesting field. During the last two years two papers by Mr. Diller, "Lassen Peak, our most active volcano," and "The geological history of Lassen Peak," have been published unofficially.

Brief examinations of a nickel prospect and a molybdenum prospect, both in San Diego County, were made by F. C. Calkins, and notes on them have been issued as Bulletin 640–D. A paper describing the occurrence of tin in this county was prepared by W. T. Schaller and issued as Bulletin 620–P. Progress has been made by Mr. Schaller in a study of the pegmatite intrusions of the county, which, in addition to containing gem minerals, present features of exceptional petrologic interest.

Field work in the Yosemite National Park was continued during the summer of 1915 by F. C. Calkins. Mr. Calkins and F. E. Matthes, who has been engaged in studying and mapping the glacial deposits, have nearly completed the writing of a geologic guidebook to the Yosemite, which is to be followed by the presentation of their scientific results in more complete and detailed form.

A detailed study of the mining geology of the northern portion of the Mother Lode district was made by Adolph Knopf, with the assistance of J. F. Hunter, jr., during a part of the field season.

A report, based on field work of previous seasons, entitled "A geologic reconnaissance of the southern Sierra escarpment," by Mr. Knopf, with a section on the stratigraphy of the Inyo Range by Edwin Kirk, has been transmitted for publication.

Notes on the petrology and economic geology of the Weaverville quadrangle are in preparation by H. G. Ferguson as contributions to the detailed study of the geology of the quadrangle, made by J. S. Diller, for folio publication.

With a view to revision of portions of the long-delayed report on the copper deposits of Shasta County, two weeks were spent in the summer of 1915 by L. C. Graton and B. S. Butler in that county. The report is awaiting final revision by Prof. Graton.

Some recently opened deposits of tungsten ore near Bishop were examined late in June, 1916, by Adolph Knopf.

The Rock Creek quadrangle is gradually being mapped in detail for folio publication by L. F. Noble, mainly at his own expense.

A large area in southern California has been covered by a reconnaissance examination, with mapping, by R. T. Hill, and a rough manuscript draft of the important results has been submitted for examination.

A traverse on the Duck Lake and Surprise Valley basin, in Nevada and California, was made by H. S. Gale in the course of his investigations of saline deposits that may contain potash salts or nitrates.

The results of experiments by W. B. Hicks in the evaporation of the brines from Searles Lake, with special reference to the recovery of the potash, have been printed in Professional Paper 98–A.

A remarkable Pliocene reef-coral fauna from Carrizo Creek, Imperial County, has been described in a report by T. W. Vaughan. All the species in this fauna are closely related to species at present living in the Gulf of Mexico and the Caribbean Sea, and most of them have near relatives in the Pliocene Caloosahatchee marl of Florida, strongly suggesting if not actually proving marine connection of the Gulf of California with the Gulf of Mexico in Pliocene time.

Progress has been made on a report describing the late Tertiary invertebrate faunas of California and other Pacific Coast States, by W. H. Dall.

A brief paper entitled "Faunal correlation of the Pacific coast Cretaceous," by T. W. Stanton, was read at the Berkeley meeting of the Paleontological Society, and two papers entitled "Notes on two conifers from the Pleistocene Rancho La Brea asphalt deposits, near Los Angeles, Cal.," and "The present status of knowledge concerning the Jurassic and Lower Cretaceous floras of the Pacific coast" have been prepared by F. H. Knowlton for unofficial publication.

Sections of Mesozoic and later rocks near Oroville, along Cache Creek near Rumsey, in the neighborhood of San Francisco, along the west side of San Joaquin Valley from El Puerto Creek to Little Panoche Creek, in the Ventura quadrangle, and at La Jolla were examined by T. W. Stanton for purposes of correlation.

COLORADO.

The survey of the eastern part of the San Juan Mountains, Colo., was continued by Whitman Cross, E. S. Larsen, jr., and J. F. Hunter, jr. The work comprised detailed reconnaissance mapping of parts of the Creede, Summitville, and Del Norte quadrangles. The geologic mapping of the Creede quadrangle was completed, the part covered during the season being about 600 square miles, as also was that part of the Summitville quadrangle in which the volcanic formations are present, embracing about 700 square miles. Messrs. Larsen and Hunter continued work in the Summitville quadrangle and also made a rapid reconnaissance of a small part of the Conejos quadrangle, on the east, for which no adequate topographic base is yet available. Preparation of material for the final general report on the geology of the San Juan area and the assembling of data resulting from the season's field work occupied Mr. Cross during a part of the winter. The collections from the Creede and Summitville quadrangles have been under study by Mr. Hunter. Field work in the Del Norte quadrangle was resumed by Mr. Larsen in June. Progress in the preparation of the San Cristobal folio has been made by Mr. Larsen.

The report on the geology and ore deposits of the Creede district, by W. H. Emmons and E. S. Larsen, jr., has been completed but has been sent to Mr. Emmons for final revision. The occurrence of unusual minerals at Wagon Wheel Gap, including the new mineral creedite, has been described by Mr. Larsen and R. C. Wells in unofficial publications.

The Pleistocene deposits in the southern portion of the Uncompahgre quadrangle and in the Needle Mountains quadrangle, in the San Juan Mountain region, were mapped in detail by W. W. Atwood, assisted by Kirtley Mather. The area thus surveyed included 700 square miles. Similar deposits in the Silverton, Telluride, and Engineer Mountain quadrangles, which A. D. Hole mapped some years ago, were studied and the necessary revision accomplished to make the work in this region conform with the more recent studies. This semidetailed mapping covered 650 square miles. In connection with the mapping of the Pleistocene deposits, Mr. Atwood and Mr. Mather have continued their study of the physiographic history of the San Juan Mountains. During the later part of the season special attention was given to the study of geologic conditions in the vicinity of reservoirs and reservoir sites in the San Juan Mountains, with a view to the preparation of a report that will be of service to engineers. To this report Mr. Hunter has contributed an account of the Mosca reservoir, in Beaver Creek Park, in the drainage basin of the South Fork of the Rio Grande, Rio Grande County.

A summary report on the economic geology of Gilpin County and adjacent portions of Clear Creek and Boulder counties, embracing the Central City district, by E. S. Bastin and J. M. Hill, was issued as Bulletin 620–M. The detailed report is in press as Professional Paper 94.

The oxidized zinc ores of Leadville are described by G. F. Loughlin in a chapter transmitted for inclusion in the monograph on the Leadville district, in preparation by J. D. Irving.

The field investigations of the deposits of oil shale in northwestern Colorado were vigorously continued by the party in charge of D. E. Winchester. Dry distillations and rough determinations of ammonium sulphate were made on the spot, in connection with measurements of the beds and mapping of the extent of the deposits. The report of tests and geologic examinations of these shales made in the summer of 1914 was revised and enlarged to include the results of the work of 1915. This report, which is now in press as Bulletin 641–F, will be a valuable addition to the knowledge of this oil shale as a future source of oil, fertilizer, and other distillation products. The large importance of these deposits, their petroleum content, and their gasoline possibilities have been noted in advance statements.

How near the country may be to the successful commercial development of these vast reserves no one can tell.

The preparation of a guidebook for the Mesa Verde National Park, by A. J. Collier, is in progress but has been interrupted by other more pressing matters.

On account of the great public demand for additional guides to the mineral resources, geology, and scenery in the Western States the preparation of a guidebook for the Denver & Rio Grande Railroad, from Denver, Colo., to Salt Lake City, Utah, was begun, and in August, 1915, M. R. Campbell, who was assigned to the task, visited all the points of interest to tourists along the main line of this road, examining the route from Florence to Grand Junction on foot and in great detail. The manuscript for this part has been prepared and will be ready for publication as soon as the work through to Salt Lake City is completed in 1916.

The detailed geology of the Castle Rock quadrangle, situated north of the Colorado Springs quadrangle, is described and mapped by G. B. Richardson in Folio 198 of the Geologic Atlas.

The stratigraphy of the rocks including the Scranton coal bed was examined in detail by W. T. Lee, whose correlations of these beds have been incorporated by Mr. Richardson in a short paper for unofficial publication.

Detailed examination of the coal resources of the Yampa field was continued in the summer of 1915 by the survey of the Pagoda quadrangle, by E. T. Hancock. This quadrangle embraces an area of 228 square miles, mainly southwest of the town of Hayden. During the winter Mr. Hancock has practically completed the preparation of the Meeker folio and the Axial and Monument Butte folio and has nearly finished an economic report on the Pagoda quadrangle.

The Grand Mesa and Book Cliffs coal fields will be treated by W. T. Lee in Professional Paper 100, "The coal fields of the United States."

In the South Platte Valley above Greeley the exposures of the Fox Hills sandstone were reviewed by T. W. Stanton, and the additional land plants obtained from this marine formation, with those previously collected by T. E. Williard from the same neighborhood, furnished the material for F. H. Knowlton's paper "Flora of the Fox Hills sandstone" (Professional Paper 98–H).

A report on the flora of the Tertiary lake beds at Florissant, Colo., was submitted for publication by F. H. Knowlton, and his paper on the flora of the Laramie of the Denver Basin is practically finished.

Phosphate beds in Colorado, Wyoming, and Utah were examined by A. R. Schultz, who also made a preliminary examination of the geology and structure of the Uinta Range.

DELAWARE.

The folio for the Elkton and Wilmington quadrangles, Del., including parts of Pennsylvania and Maryland, has been revised by Florence Bascom and B. L. Miller and is ready for publication.

The greensands of the State were examined by W. C. Phalen and G. H. Ashley, who collected samples for chemical analysis and study with special reference to their possible utilization for their potash and phosphate contents.

DISTRICT OF COLUMBIA.

Incidentally and largely as by-products of unofficial activities data have been gathered by E. W. Shaw, Arthur Keith, and others for use in mapping the geology of the area including the city of Washington on the new topographic map for the District, now nearly completed.

The Miocene flora from the Benning Road near the District line is described by E. W. Berry in Professional Paper 98–F.

FLORIDA.

The geologic work of the Survey in Florida was directed mainly toward the differentiation and definition of the Tertiary formations and the unraveling of the geologic history of the region, which is closely bound in its later history to the Central American province. Investigations of the stratigraphy and paleontology of the Eocene and lower Oligocene formations were continued by C. W. Cooke. Miss J. A. Gardner devoted most of the year to monographing the fossil Mollusca of the Chipola, Oak Grove, and Shoal River members of the upper Oligocene Alum Bluff formation. J. A. Cushman is describing the orbitoid and nummulitid Foraminifera. The molluscan faunas of the Choctawhatchee marl of Red Bay and the Pliocene Mollusca of Deland were studied and reports on them prepared by W. C. Mansfield. The older Tertiary Bryozoa of the State are described in a manuscript by F. Canu and R. S. Bassler. In cooperation with the Carnegie Institution of Washington, investigations of the Florida living corals, the coral reefs, and the keys were continued by T. W. Vaughan and E. W. Shaw. Special attention was paid to the physiography, including detailed investigations of the agencies determining the shapes of the keys, and to bottom deposits that are now being formed off the south coast of Florida.

Papers on the geology of the State or on geologic processes operative there were published or submitted for publication during the year as follows: The phosphate deposits of Florida are described in Bulletin 604, by G. C. Matson; the age of the Ocala limestone is the subject of a paper by C. W. Cooke (Professional Paper 95–I); the physical conditions and age indicated by the flora of the Alum Bluff formation are discussed in Professional Paper 98–E by E. W. Berry; the extension of the Citronelle formation into western Florida is considered by Mr. Matson in Professional Paper 98–L (in press); several papers on the living corals and coral reefs and geology of southern Florida were published outside of the Survey by T. W. Vaughan and E. W. Shaw; a report on the salinity of the ocean water at Fowey Rocks was written by R. B. Dole and A. A. Chambers; and a paper on the temperature of the Florida coral-reef tract was prepared by Mr. Vaughan.

GEORGIA.

In order to procure data for the use of chemical engineers as to the practicability of utilizing the sericite deposits of Georgia for the production of potash the principal sericite districts in the State were investigated by P. S. Smith with reference both to the quantities of the material at certain points and to the potash contents of the veins that are of workable thickness. Samples were collected at many places in the vicinity of Jasper and Blue Ridge for chemical analysis, the results of which will be published at an early date.

The water supply of Savannah was investigated by R. B. Dole and L. W. Stephenson, and the municipal authorities were advised as to the best means of remedying the defects that were causing pollution and of increasing and maintaining the supply to meet future demands.

Progress was made in the preparation of a report on the upper Eocene and lower Oligocene formations of the State, and field work on the Claiborne and Jackson groups in a number of counties was done by C. W. Cooke.

Collections of Cretaceous and Tertiary plants were studied by E. W. Berry, who has nearly completed a report on the fossil floras of Claiborne and Jackson age. The orbitoid and nummulitid Foraminifera of the State are being studied by J. A. Cushman, and the upper Oligocene Mollusca from Bainbridge have been described by W. H. Dall. The older Tertiary Bryozoa of the State are described in a manuscript by F. Canu and R. S. Bassler. Notes on the upper Eocene and lower Oligocene formations of the State are contained in C. W. Cooke's paper on the age of the Ocala limestone (Professional Paper 95–I).

A molluscan fauna of Oligocene age collected on Flint River has been described by W. H. Dall in a paper to be published by the United States National Museum.

A bulletin on the red iron ores of northwestern Georgia, northeastern Alabama, and eastern Tennessee, by E. F. Burchard, based on field work done in previous seasons, is near completion.

IDAHO.

Field work for a comprehensive summary report on the geology and ore deposits of Idaho was continued during the year by J. B. Umpleby and E. L. Jones, jr. The deposits of Washington, Adams, and Canyon counties were examined by Mr. Umpleby; those of Boise, Elmore, Ada, Owyhee, and Gem counties by Mr. Jones, whose reconnaissance covered approximately 850 square miles. A short report on lode mining in the Quartzburg and Grimes Pass porphyry belt, Boise Basin, was prepared by Mr. Jones and submitted for publication as Bulletin 640–E. In May, 1916, Mr. Umpleby, with Mr. Jones, began the study of the deposits in the Coeur d'Alene district as opened by mining operations since the detailed examination by F. L. Ransome and F. C. Calkins in 1904. In connection with this work a reconnaissance examination was made of the Pine Creek district, south of Kellogg.

The economic section of the Hailey folio was completed by Mr. Umpleby and is now awaiting the completion of the part on general geology by L. G. Westgate, to whom no allotment could be made but who has continued office work on his manuscript.

Bulletin 620–L, "Notes on the fine gold of Snake River, Idaho," by J. M. Hill, based on field work done in a previous season, was issued during the year.

Investigations of the fuel resources of the State are reported in Bulletin 621–I, "The Orofino coal field, Clearwater, Lewis, and Idaho counties, Idaho," by C. T. Lupton.

Data for a report on the building stones of the State are being gathered by G. F. Loughlin.

A detailed report on the ore deposits of the Mackay region, by J. B. Umpleby, is now in press as Professional Paper 97.

Detailed geologic mapping of the Slug Creek, Lanes Creek, and Freedom quadrangles, done in previous seasons by G. R. Mansfield and assistants, was reviewed by Mr. Mansfield during two weeks in July, 1915, the scattered areas reexamined aggregating about 100 square miles. A paper entitled "A revision of the Beckwith and Bear River formations of southeastern Idaho," written incidentally to the preparation of the folios covering the quadrangles mentioned, was published as Professional Paper 98–G.

ILLINOIS.

The geologic investigations in and about the Illinois coal field were, as in preceding years, continued in cooperation with the State Geological Survey. The work of the year was characterized not so much by its extension into new areas as by the completion of manuscripts and maps for areas that had been already investigated or were under examination.

In the Shawneetown and Equality quadrangles the stratigraphy and structure were studied by Wallace Lee, who mapped the Mississippian portion of the Shawneetown quadrangle, in which the determination of the structure is complicated by the mantle of loess and by faults. To unravel the stratigraphy in this area it was found necessary to make reconnaissance studies in company with Stuart Weller in the Golconda quadrangle and in the Elizabethtown region. Field work in the Shawneetown quadrangle, about one-third of which lies in Kentucky, was nearly completed, and the report by Mr. Lee on the Kentucky area, mapped in cooperation with the Kentucky Geological Survey, was transmitted to that State for publication. A reconnaissance was made of the coal measures in portions of the Pennsylvanian area in the Equality quadrangle.

The manuscript and maps for a folio to cover the Gillespie and Mount Olive quadrangles, examined by Mr. Lee in 1914, were finished and submitted for critical review. The folds in these quadrangles, contoured in the report earlier submitted to the State for publication, have in part been tested with favorable results. The geologic examination and mapping of the Birds quadrangle, in which the State Survey had previously investigated the structure and oil and gas resources, was completed by T. E. Savage, under agreement, and the folio, to include the descriptions and maps of the Birds and Hardinville quadrangles, was nearly finished by Mr. Savage, who has also, under agreement, concluded the field investigations necessary for the preparation of a report on the Vincennes quadrangle, a portion of which lies in Indiana.

Manuscripts and maps for two folios covering the Canton and Avon quadrangles, by Mr. Savage, and the La Salle and Hennepin quadrangles, by U. S. Grant and H. D. Cady, have been transmitted by the State Survey to the Federal Survey for publication. These folios represent State work exclusively and were transmitted as a part of its cooperation.

Several problems of the Pleistocene in this State received considerable attention. An account of the extinct lakes in southern and western Illinois, based on field examinations made by E. W. Shaw, were transmitted to the State Geological Survey for publication. Mr. Shaw's study of the surficial geology of the Gulf embayment in the southernmost counties of Illinois was continued.

Critical comparison and differentiation of the Illinoian drift and associated deposits from the post-Kansan drift of northeastern Iowa were made by W. C. Alden in the Edgington and Milan quadrangles and in Henry County.

The upper Mississippian rocks in southern Illinois, western Kentucky, and eastern Missouri were examined in conference by G. H.

irty, Stuart Weller, and Charles Butts with the object of bettering he classification and determining the equivalents of the strata in ifferent regions of the Mississippi Valley. This is a part of a gen- ral investigation in which the State geological surveys of Illinois, Missouri, Kentucky, Tennessee, Iowa, and Oklahoma are cooperating with the Federal Survey. The correlation of the Chester formations in Illinois and adjacent States was discussed by E. O. Ulrich in a paper read before the Paleontological Society.

IOWA.

The cooperative investigation of the evidence of an Iowan stage of glaciation was continued by W. C. Alden for the Federal Survey, assisted by M. M. Leighton, of the Iowa Geological Survey. Considerable progress has been made on the report of this work, some preliminary results of which have already been made public by Mr. Alden.

KANSAS.

A comprehensive report on the origin of the zinc and lead deposits of the Joplin region, by C. E. Siebenthal, field studies in connection with which extended into southeastern Kansas, was issued during the year as Bulletin 606.

The stratigraphy and structure of small areas in southeastern Cawley and southwestern Chautauqua counties, bordering the Foraker quadrangle (Oklahoma), were examined by K. C. Heald in connection with the study of the structure and oil prospects in the quadrangle.

The Syracuse-Lakin folio, by N. H. Darton, has been submitted for publication.

KENTUCKY.

Nearly all the geologic work done by this Survey in Kentucky was carried on in efficient cooperation with the State Geological Survey.

The Kentucky portion (about one-third) of the Shawneetown quadrangle was examined and mapped in detail by Wallace Lee, and a report by Mr. Lee on the economic geology of the quadrangle was transmitted for publication by the Kentucky Geological Survey, in cooperation with which the work was done.

A report on the general geology and mineral resources of Jefferson County was completed early in the year by Charles Butts and has been published by the Kentucky Geological Survey. This work is contributory to a geologic folio to cover the Louisville and Kosmosdale quadrangles, after more data on certain problems are procured and some small areas outside of the county are mapped.

A detailed reconnaissance of the stratigraphy for purposes of formational definition and correlation of the Mississippian formations in west-central Kentucky was begun by Mr. Butts. The results of this work, one-half of the cost of which was borne by the State, will be submitted to the State for publication.

A reconnaissance field study of formations of late Trenton age in central Kentucky was made by E. O. Ulrich.

The later Tertiary and Pleistocene history of the western part of the State is being specially studied by E. W. Shaw. The erosion intervals during Eocene time are considered by E. W. Berry in Professional Paper 95–F, and a paper on the old Eocene floras, by Mr. Berry (Professional Paper 91), is almost ready for distribution.

LOUISIANA.

Investigations of the oil fields and oil and gas indications in Louisiana were continued during the fiscal year, and field work was completed for a report on the oil fields of De Soto and Red River parishes. The results will be embodied in a report by G. C. Matson and O. B. Hopkins, to be published during the coming year. The report on the Caddo oil and gas field, by Mr. Matson, has been published as Bulletin 619.

Special investigations were made in Natchitoches Parish near Campti and Natchitoches, in Sabine Parish near Pelican, in Tensas Parish near Point Pleasant, and in Cameron Parish near Cameron. The results of these studies will not appear in special reports but will be incorporated in a bulletin containing descriptions of the oil and gas fields and oil and gas indications in Louisiana that is now being prepared by Messrs. Matson and Hopkins. Samples of the oil and gas in the Caddo, De Soto, Shreveport, and Pelican districts were collected and submitted to the Bureau of Mines for examination. The results of these examinations will probably be published in the report on the fields in De Soto and Red River parishes.

Two reports by G. C. Matson and E. W. Berry, "The Pliocene Citronelle formation of the Gulf Coastal Plain and its flora" (Professional Paper 98–L) and "The Catahoula sandstone and its flora" (Professional Paper 98–M), were submitted for publication, and collections of fossils, both from surface outcrops and from deep wells in Louisiana, were studied and reported on by the Survey paleontologists. A report on the flora of the Jackson and Claiborne groups has been almost completed by E. W. Berry, and a monographic account of the old Eocene floras is almost ready for distribution as Professional Paper 91. The orbitoid Foraminifera are being studied by J. A. Cushman.

A report on iron-bearing deposits in Bossier, Caddo, and Webster parishes, by E. F. Burchard, was published as Bulletin 620–G.

MAINE.

The detailed mapping of the Portland and Casco Bay quadrangles, Maine, was reviewed by F. J. Katz, principally to adjust previous mapping to fit the new topographic base. An area of about 350 square miles in the Biddeford, Kennebunk, Buxton, and Berwick quadrangles was covered in reconnaissance by Mr. Katz.

A study of the coastal marshes and peat bogs in the quadrangles above mentioned was made by Mr. Katz, with the late Prof. C. A. Davis, special attention being given to the evidence showing very recent subsidence of the coast.

The Dover and York quadrangles were covered in reconnaissance by Mr. Katz, and the broader structural features as well as the formations to be mapped were roughly determined. About 55 square miles in the center of the district was surveyed in detail.

As a result of field examinations and conferences between Arthur Keith, Laurence LaForge, and Mr. Katz in the area embracing parts of the Kennebunk, Biddeford, Portland, Casco Bay, Dover, and York quadrangles, conclusions were reached as to the stratigraphy of the rocks in these quadrangles and their correlation with areas being geologically mapped in Massachusetts. Some of these conclusions have been incorporated in the Portland-Casco Bay folio, which is approaching completion.

A report on the fauna of the Chapman sandstone, by H. S. Williams, assisted by C. L. Breger, has been published as Professional Paper 89.

MARYLAND.

A brief reconnaissance of the Baltimore and Parkton quadrangles, Md., and an investigation of the Baltimore gneiss were made by Eleanora F. Bliss.

The maps and descriptions of the Williamsport quadrangle, which will be covered by the Williamsport-Hagerstown folio, have been well advanced by G. W. Stose. This folio will be published in cooperation with the Maryland Geological Survey, but the area mapped includes parts of West Virginia and Pennsylvania.

The folio for the Elkton and Wilmington quadrangles, which was prepared by Miss Florence Bascom and B. L. Miller, in cooperation with the Maryland Geological Survey, has been revised and is ready for publication. These quadrangles include parts of Pennsylvania and Delaware.

The Tolchester folio, also prepared under cooperative auspices by B. L. Miller, E. B. Mathews, Arthur Bibbins, and H. P. Little, has been revised and is in course of publication.

The results of the examinations of manganese mines and deposits in Maryland and Virginia by D. F. Hewett are included in a preliminary paper published as Bulletin 640–C.

Extensive prospecting recently accomplished in the gold-quartz veins in the vicinity of Great Falls was inspected by Arthur Keith, F. L. Ransome, and J. M. Hill.

The Frostburg-Flintstone folio awaits the completion by the State Geological Survey of its part of the text and maps.

Data for use in mapping in detail the geology of the area to be covered by the new large-scale topographic map including the District of Columbia, now in preparation by the topographic branch, are being assembled by Arthur Keith, E. W. Shaw, N. H. Darton, and others.

At the request of the municipal authorities the water supply of Hyattsville was examined, and suggstions were made in regard to increasing the supply to meet the demands of the community.

The greensands on Severn River and about Marlboro were examined by G. H. Ashley, and samples were collected for analysis and study with special reference to their potash content.

MASSACHUSETTS.

A description of the topography of Massachusetts was prepared by Arthur Keith for publication in a paper on the surface waters of that State, to be issued as Water-Supply Paper 415.

Recconnaissance examinations in the Haverhill, Lowell, Lawrence, Newburyport, Salem, and Groton quardrangles, Mass., and in the Milford and Manchester quadrangles, N. H., and adjacent territory were made by Laurence LaForge, who, in much of this area, as well as in critical localities in the Worcester area, was accompanied by Arthur Keith. The western margin of the Lowell quadrangle and the eastern margin of the Groton quadrangle were mapped in detail by Mr. LaForge.

Detailed mapping of the Newbury Basin by Mr. LaForge was inspected by Mr. Keith, who discovered late Silurian or early Devonian fossils in one of the volcanic formations in the Rowley quadrangle, from which a collection was later made by Mr. LaForge in company with R. D. Mesler. A description of the geology of northeastern Massachusetts based on this and a previous reconnaissance was prepared by Mr. LaForge and is incorporated in the report on the geology of Massachusetts and Rhode Island by Prof. B. K. Emerson, which has been revised and is now in press as Bulletin 597.

A brief reconnaissance of the Barre quadrangle was made by Arthur Keith, who also examined the Devonian rocks in the Greenfield quadrangle.

The areal and economic survey of the Greylock quadrangle was continued by L. M. Prindle, about 65 square miles being covered in detail.

The Devonian formations in the Greenfield (Mass.), Brattleboro (Vt.), and Keene (N. H.) quadrangles were critically examined, and a brief inspection of the area south of Williamstown was made by Mr. Keith.

Geologically important points in the Sheffield, Sandisfield, and Becket quadrangles were inspected by Mr. Keith in connection with the criticism of the folios for these areas, which have been submitted for publication.

The mapping of the surface geology of the Warwick, Winchendon, Fitchburg, and Groton quadrangles was continued during the field season by Prof. B. K. Emerson. Work on the text and maps for the two folios covering these quadrangles is well advanced.

In the Boston and Boston Bay quadrangles some additional field work was done by Mr. LaForge. The descriptions and maps of these quadrangles for the Boston folio are well advanced. In the Framingham quadrangle further revisions of the geologic and topographic maps were made by Mr. LaForge for incorporation in the Boston folio.

Field work has been done on the islands south of Rhode Island and the mainland of Massachusetts and on Cape Cod by J. B. Woodworth. The office work preliminary to writing a report on the results of the investigations is well advanced. Collections of fossil plants from Marthas Vineyard have been reported on by E. W. Berry.

In connection with the study of the glacial and older deposits of this region by Mr. Woodworth, a field conference of several days in June was held with W. C. Alden.

The manuscript, maps, and illustrations for the Pleistocene portion of the folio covering the Berlin and Greylock quadrangles, in New York and Massachusetts, were submited for publication by F. B. Taylor, who also transmitted the illustrations for the Pittsfield-Becket and Sheffield-Sandisfield folios, covering quadrangles in New York and Massachusetts.

MICHIGAN.

The gypsum deposits of Michigan are described in a general report on the gypsum deposits of the United States, in preparation by R. W. Stone.

The fauna of the Marshall group is in process of description by G. H. Girty, who is making this study in cooperation with the Michigan Geological Survey.

The geology of the Detroit quadrangle is described and mapped in a folio by W. H. Sherzer now in press. This folio was prepared in cooperation with the State Geological Survey.

MINNESOTA.

The cooperative studies begun last year by this Survey and the Minnesota State Survey, leading to reports on the economic geology of the Cuyuna iron range, were continued. The rock outcrops over an area of about 30 townships in central Minnesota were mapped in detail, and detailed topographic and geologic maps of open pits were made. Numerous drill samples were examined in areas in which no outcrops occur. The cores of 265 drill holes, aggregating 53,270 feet, were examined. The resulting reports are about to be submitted by E. C. Harder. One relates to the geology of east-central Minnesota, including the Cuyuna range. The other report discusses the physiology, morphology, and activity of iron-depositing bacteria and the formation of certain iron-ore deposits; it also contains a statement of the relative importance of chemical and biologic processes in iron-ore deposition.

The mapping and study of the glacial and associated deposits of Minnesota, which has been carried on under cooperative agreement between the Federal and Minnesota geological surveys, was completed by Frank Leverett, assisted by F. W. Sardeson, of the Minnesota Survey. A report on the surface formations and agricultural conditions of northeastern Minnesota was completed and transmitted for publication by the State in December. The map and manuscript for the report on the southern half of Minnesota, describing the several classes of drift and their soils, was transmitted by Mr. Leverett for publication. A general report on the Quaternary formations of Minnesota is in preparation by Mr. Leverett for publication by the Federal Survey.

Two reports, one on the building stones of Minnesota, by Oliver Bowles, and the other on the clays of the State, by F. F. Grout, prepared under cooperative agreement, have been submitted for publication as bulletins of this Survey.

Folio 201, describing in detail the geology of the four 15-minute quadrangles of the Minneapolis and St. Paul area, by F. W. Sardeson, has been issued. This publication is of more than ordinary educational value.

MISSISSIPPI.

Reports on the physiography and the stratigraphy of the Cretaceous and Tertiary deposits of Mississippi and on the ground waters of the State are being prepared in cooperation with the Mississippi Geological Survey and are about half completed.

The orbitoid and nummulitid Foraminifera are being investigated by J. A. Cushman. A report on the floras of the Jackson and Claiborne groups has been almost completed by E. W. Berry; and the older Tertiary Bryozoa are described in a manuscript by F. Canu and R. S. Bassler.

The following publications relating to the Coastal Plain formations have been published or submitted for publication during the year: "Erosion intervals in the Eocene of the Mississippi embayment" (Professional Paper 95–F) and "The physical conditions and age indicated by the flora of the Alum Bluff formation" (Professional Paper 98–E), by E. W. Berry; "The Pliocene Citronelle formation and its flora" (Professional Paper 98–L) and "The Catahoula sandstone and its flora" (Professional Paper 98–M), by G. C. Matson and E. W. Berry; "The age of the Ocala limestone" (Professional Paper 95–I), by C. W. Cooke. A paper on the lower Eocene floras by Mr. Berry (Professional Paper 91) was in press at the close of the year.

In view of the importance, both to the State and to the Nation, of the discovery of petroleum in the Coastal Plain east of Mississippi River, work was begun late in 1914 in the search for areas of structure favorable for the occurrence of petroleum in that region, for while the presence of such structure is but one important factor in the occurrence of oil pools it was believed that the discovery of the structure would not only encourage oil operators to make tests, but, by leading them to more favorable localities, would tend to eliminate the losses and discouragement that would arise from necessarily fruitless drilling in places where the structure is not favorable. Structural investigations begun near Vicksburg, Warren County, during the last fiscal year, were this year continued across parts of Hinds and Rankin counties. The results of these investigations, which were in part announced in a press notice last year, are being published as Bulletin 641–D, "Structure of the Vicksburg-Jackson area, Mississippi, with special reference to oil and gas," by O. B. Hopkins. A brief examination of reported oil indications in Jackson County, near Pascagoula, was made by Mr. Hopkins.

MISSOURI.

In Missouri the cooperation of the State has been continued in areal and paleontologic work. In the mapping of the general geology and mineral resources of Ste. Genevieve County, which embraces portions of several quadrangles, the State Bureau of Economic Geology and Mines has performed by far the greater part of the work, and the mapping of the county for State publication is completed. Field examinations necessary to the mapping of the portions of the Farmington and Weingarten quadrangles lying outside of Ste. Genevieve County were completed under Federal auspices by Stuart St. Clair and F. C. Greene.

In connection with the joint cooperation of the surveys in the States bordering Mississippi River and containing geologic formations of Mississippian age, paleontologic studies have been systematically organized for purposes of classification and correlation, and field conferences between State and Survey geologists and paleontologists were held at a number of critical points.

The folio by F. C. Greene and Henry Hinds, covering the Leavenworth and Smithville quadrangles, including a portion of Kansas, is now in press. The text of the Green City folio is in the hands of Mr. Greene for final revision.

Bulletin 606, on the origin of the Joplin lead and zinc ores, by C. E. Siebenthal, the result of a long-continued and thorough investigation of the geology and ore deposits of the Joplin region, was issued during the year.

The formations in southeastern Missouri included in the proposed "Ozarkian" system were reviewed by E. O. Ulrich in association with State Geologist H. A. Buehler.

MONTANA.

The lignite field in the northeast corner of Montana, north of the Fort Peck Indian Reservation, was examined by A. J. Collier, assisted by W. T. Thom, jr., and Raymond Baker. An area of about 1,900 square miles was examined in a detailed reconnaissance, in order that the land might be classified and the coal land thrown open to purchase. The data for the classification of the land have been submitted to the land-classification board, and an account of the geology and lignite resources of the region has also been prepared by Mr. Collier, but the submission of this report has been delayed in order that it might be extended to include the description of adjacent areas, the examination of which was begun in June.

The economic report on the Ekalaka coal field of southeastern Montana was completed by C. M. Bauer and will be submitted for publication in "Contributions to economic geology."

An examination of that part of the Milk River coal field which lies north of the area already examined by L. J. Pepperberg, extending from R. 8 E. to R. 24 E. and embracing about 1,590 square miles, was made by Eugene Stebinger, assisted by W. P. Woodring and J. D. Sears. The data regarding the land in this field have been submitted to the land-classification board, and some progress has been made in the preparation of a report. A rapid reconnaissance of 250 square miles southeast of the mouth of Judith River was also made by Mr. Stebinger and his party, and the land has been classified and appraised.

Reports on the oil possibilities of north-central Montana, including an account of the large gas well near Havre (Bulletin 641–C), and on anticlines in the Blackfeet Indian Reservation, treating mainly of the belt of disturbed rocks just east of the Rocky Mountain front (Bulletin 641–J), have been prepared and submitted by Mr. Stebinger.

Considerable progress has been made by Mr. Stebinger in the preparation of the Blackfeet-Cut Bank folio.

The report on the geology and coal resources of northern Teton County, by Mr. Stebinger, has been published as Bulletin 621–K; and Folio 196, covering the Philipsburg quadrangle, by F. C. Calkins and W. H. Emmons, has been issued.

The examination of an area in Yellowstone Valley west of Billings for the purpose of locating and mapping anticlines and procuring evidence as to whether or not they contain oil was begun in June, 1916, by E. T. Hancock, assisted by W. T. Thom, jr., and J. D. Sears. Similar investigations in the Mussellshell Valley west of Roundup were begun at the same time by C. F. Bowen, assisted by W. P. Woodring. A paper entitled "Gradation from continental to marine conditions of deposition in central Montana during the Eagle and Judith River epochs," based on studies in Montana in 1914, was offered by Mr. Bowen for Survey publication.

At the close of his work in the Bighorn Basin, Wyo., C. J. Hares made a hurried examination of the Hailstone Basin, about 40 miles northwest of Billings. This basin is eroded in an anticline, and Mr. Hares examined it for the purpose of determining whether or not the stratigraphy and structure are favorable for the occurrence of oil. His report has been prepared and submitted for publication.

In connection with an examination of certain outlying phosphate lands in Granite County and of the Pioneer gold placer district in Powell County, begun early in June, 1916, by J. T. Pardee, an area of approximately 75 square miles was geologically surveyed in semidetail. The withdrawn phosphate lands in the vicinity of Helena were examined in May and June by A. R. Schultz.

A bulletin on the phosphate deposits of the Garrison and Philipsburg areas was completed by J. T. Pardee and transmitted for publication as Bulletin 640–K.

A paper on the Jefferson limestone was prepared by Edwin Kirk for unofficial publication. Some work was done by W. C. Alden on a paper discussing the glaciation in Glacier National Park.

NEVADA.

In pursuance of an investigation of the enrichment of silver ores, which has been in progress for some time, E. S. Bastin spent a week at Virginia City, Nev., in the summer of 1915. A report prepared by Mr. Bastin, in collaboration with F. B. Laney, on the genesis of the ores of Tonopah, as interpreted from detailed microscopic studies of polished surfaces of the ores, was transmitted for publication.

Four months of field work, mostly in the Manhattan district but including reconnaissance work in the Round Mountain, Jefferson, Belmont, and Golden Arrow districts, was done by H. G. Ferguson; and a report on the Golden Arrow and Clifford districts has been transmitted for publication as Bulletin 640–F. Mr. Ferguson has in preparation a report on the geology and ore deposits of the Toquima Range, including the Manhattan district.

A report on the copper deposits of the Yerington district is in preparation by Adolph Knopf. Late in June, 1916, Mr. Knopf investigated reported discoveries of tin ore in the region north of Elko.

A detailed report on the geology and ore deposits of the Ely district, by A. C. Spencer, to be issued as Professional Paper 96, is now in press.

A report on the geology and mineral deposits of the National mining district, by Waldemar Lindgren, has been issued as Bulletin 601.

A reconnaissance report by J. M. Hill on some mining districts in eastern Nevada, mostly in Elko, White Pine, Lincoln, and Clark counties, and on the Ravenswood district, in Lander County, is in press as Bulletin 648. A short report on the ore deposits at Eureka is in hand by G. F. Loughlin.

In pursuance of the plan announced in last year's report for continuing the search for potash, four wells were drilled in the Smoke Creek Desert. Well No. 1, in approximate sec. 14, T. 32 N., R. 21 E. (unsurveyed), was begun July 25, 1915, and drilled to a depth of 310 feet the first day. This well was completed to a depth of 1,200 feet on August 4. Well No. 2, in approximate sec. 8, T. 31 N., R. 21 E. (unsurveyed), was begun August 14 and drilled 145 feet the first day. This hole reached a depth of 680 feet and was then abandoned. Well No. 3, in the southeast corner of sec. 34, T. 31 N., R. 20 E., was begun September 2 and reached a depth of 233 feet the same day and 563 feet the second day. In the night of September 9, when the well was at a depth of 957 feet, an artesian flow of salty water broke out, measuring about 425 gallons a minute. On the flat mud surface, where access was made possible only by the unusual dryness of the season, this flow quickly made further work at this site impossible, and the hole was abandoned. Well No. 4, in approximate sec. 16, T. 29 N., R. 20 E. (unsurveyed), was begun September 23 and reached a depth of 173 feet the same day. This well was completed at a depth of 1,360.7 feet on October 6, the immediate cause of stoppage at this particular depth being a breakage of the hydraulic pumps. These wells give an interesting geologic record concerning these basins and serve as a practical basis for judgment, especially as regards artesian conditions, with regard to a large area of public lands for which as yet little use has been found, although a commercial amount of potash, the principal object of the search, was not discovered. The logs and samples from these wells will be studied and made a matter of record.

A brief examination with sampling of the Washeim niter claims, near White Plains, was made by H. S. Gale, who, in the course of his investigation for potash and niter salts, visited the Desert Crystal Works, now operating at Huxley, and made traverses of the Duck Lake and Surprise Valley basin, in Nevada and California, and of the upper Quinn River valley.

A very large deposit in the Muddy River valley, near St. Thomas, which had previously been known and exploited as kaolin was recognized as magnesite by Mr. Gale. An examination was made of the deposit and a press announcement was made by the Survey, calling attention to the availability of this material as a source of magnesia, which is one of the materials urgently needed because of the war stoppage of imports.

The alunite deposits 22 miles southwest of Las Vegas were examined and sampled by Mr. Gale, and the great natural cliffs of rock salt exposed along the lower part of Virgin River, in southern Nevada, were examined and sampled by him with reference to a possible potash content.

The study of the sedimentary record in the Black Rock Basin was continued by M. I. Goldman, but this work has not yet been brought to a definite conclusion.

NEW HAMPSHIRE.

Mapping of the surface geology of the Keene and Monadnock quadrangles, N. H., was carried forward by Prof. B. K. Emerson, who made considerable progress on the texts and maps for these areas. A brief reconnaissance of the bedrock geology of the Keene quadrangle was made by Arthur Keith.

A paper describing the Newington moraine, in southeastern New Hampshire, and its extensions into Maine and Massachusetts (Professional Paper 108–B) was prepared for publication by F. J. Katz, in association with Arthur Keith.

Detailed geologic studies and areal mapping of the Dover and York quadrangles, which include parts of Maine, were continued by Mr. Katz. A study of the peat deposits and phenomena of the coastal subsidence in these quadrangles was made by Mr. Katz in company with the late Prof. C. A. Davis, and reconnaissance studies were made by Mr. Keith. Office work by Mr. Katz on the maps and collections for the Dover-York folio is progressing.

A general investigation of the plateaus of the northern Piedmont region was begun by Mr. Keith for the purpose of correlating the local features.

NEW JERSEY.

A critical comparison of the morainal and extramorainal drift in the Easton quadrangle, N. J., was made the subject of a field conference between the State geologist and W. C. Alden in June.

The greensand belt was examined by W. C. Phalen and sampled for chemical analysis with special reference to the availability of the sands as a source of potash. The results of the analyses are in part cited in the report on the production of potash in 1915, published as a chapter of Mineral Resources.

A description of the origin of the salient topographic and scenic features in the Delaware Water Gap quadrangle, which includes also a part of Pennsylvania, was prepared by G. W. Stose and printed on the back of the topographic map of the area.

NEW MEXICO.

The examination of the Raton coal field, N. Mex., which has been in progress for several field seasons, was continued during July, 1915, by W. T. Lee, who made a detailed survey of about 32 square miles of coal land in the Koehler quadrangle.

A folio covering the Raton and Brilliant quadrangles has been submitted for publication by Mr. Lee, with a section on petrography by J. B. Mertie, jr.

To procure data for the more satisfactory settlement of certain questions relating to geologic structure and the correlation of formations, as well as to the classification and valuation of land in the San Juan Basin, in northwestern New Mexico, accurate areal work in this basin was begun in June, 1915, by C. M. Bauer, assisted by J. B. Reeside, jr., and H. R. Bennett. A large area extending south of San Juan River and up Chaco River to Meyers Creek, embracing about 1,300 square miles, was examined and mapped by plane-table methods. The results of this work are in part embodied in a paper entitled "Stratigraphy of a part of the Chaco River valley." This paper, which describes the later Cretaceous formations, serves as a general geologic introduction to three paleontologic papers on the fossils collected by this party. The four papers have been submitted for publication in "Shorter contributions to general geology, 1916" (Professional Papers 98–P to 98–S) under the general title "Contributions to the geology and paleontology of San Juan County, N. Mex." The vertebrate fossils are described by C. W. Gilmore, the invertebrate fossils by T. W. Stanton, and the fossil plants by F. H. Knowlton. Another paper on the coals of the Fruitland formation was completed and submitted by Mr. Bauer prior to his resignation in May to enter the service of one of the large oil companies.

A general report on the Datil Mountain coal field, by D. E. Winchester, is now about half completed, and another on the geology of the Zuni Indian Reservation is in progress, but both papers have been set aside temporarily on account of Mr. Winchester's investigations of oil shales in Colorado and Utah.

Field examinations of the "Red Beds" and their included saline and gypsum deposits were continued by N. H. Darton. These investigations, which have for their object the interpretation of the history of the deposition of this series of beds and especially the determination of the centers of greatest saline precipitation and consequently the areas in which beds of potash salts are more likely to be present, covered a large part of New Mexico and indicated that the principal saline deposits were in the eastern part of the State.

The nitrate claims in the vicinity of Rodeo were examined and sampled by H. S. Gale.

The copper deposits of the Burro Mountains (Tyrone district), in the southern part of the State, were studied by Sidney Paige, who geologically mapped 35 square miles in detail. His report on this district will be submitted early in the coming fiscal year.

The geology and copper deposits of the Santa Rita district, which A. C. Spencer and his associates have studied for portions of two field seasons, form the subject of a report now in preparation by Mr. Spencer.

Two weeks were spent at Magdalena in the summer of 1915 by G. F. Loughlin preparatory to making a detailed survey of the district during the summer of 1916. Mr. Loughlin's work was primarily underground, though it included about 5 square miles of reconnaissance surveying.

The Silver City folio (No. 199), prepared by Sidney Paige, and Bulletin 618, "Geology and underground waters of Luna County, N. Mex.," by N. H. Darton, were published in April. The folio for the Deming quadrangle, by Mr. Darton, is now in process of engraving and printing.

A report on the Navajo country, a reconnaissance of parts of Arizona, New Mexico, and Utah, by H. E. Gregory, has been submitted for publication as Professional Paper 93.

NEW YORK.

The areal and economic survey of the Berlin quadrangle, N. Y., including a small area in Massachusetts, was continued by L. M. Prindle, who mapped in detail about 10 square miles. Office work on the Berlin-Greylock folio text and maps is well advanced toward completion. The manuscript, maps, and illustrations describing the Pleistocene formations were submitted by F. B. Taylor for inclusion in this folio.

The glacial phenomena of the Cambridge, Equinox, and adjacent quadrangles were reviewed by Mr. Taylor and W. C. Alden in June.

The illustrations for the Pleistocene portions of the Pittsfield-Becket and Sheffield-Sandisfield folios, covering quadrangles in New York and Massachusetts, were submitted by Mr. Taylor, who also completed the corresponding portion of the Hoosic-Bennington folio, covering quadrangles in New York, Vermont, and Massachusetts.

NORTH CAROLINA.

The text and maps for the Kings Mountain and Gaffney quadrangles, partly in North Carolina but mostly in South Carolina, were practically completed by D. B. Sterrett, and the folio covering them is nearly ready to be submitted for publication. The maps and descriptions of the Lincolnton quadrangle are also nearly completed by Mr. Sterrett, but it is planned that this quadrangle will be described in a folio together with the Gastonia quadrangle, in which work will be undertaken later.

A report by L. W. Stephenson on the Cretáceous Coelenterata, Vermes, and Mollusca of North Carolina has been completed and transmitted for publication. This report is cooperative and is to be published by the State as part of a monograph on the Cretaceous faunas and floras.

A report on the Tertiary invertebrates of the State is nearly ready for submission. The older Tertiary Bryozoa are described in a report, now almost completed, by F. Canu and R. S. Bassler.

The sericite rocks in the vicinity of Gold Hill and Kings Mountain were examined by P. S. Smith with the object of determining their potash content and the purity and thickness of sericite that may be available in the best localities known. Samples were collected at many places for chemical analysis in the Survey laboratory. The results will be published at an early date.

In order to gain both chemical and quantitative information as to the rocks in the Eastern States that may be used for potash extraction or potash fertilizers, the greensands on Contentnea Creek were examined by G. H. Ashley and sampled for analysis and study.

NORTH DAKOTA.

The lignite resources of the New Salem lignite fields are described in detail by E. T. Hancock in a paper submitted for bulletin publication.

A general description of the lignite fields of North Dakota, to be published as a part of Professional Paper 100, " The coal fields of the United States," was prepared by C. J. Hares and C. M. Bauer.

A report on the Edgeley and Lamoure quadrangles for folio publication was submitted by H. A. Hard, a local geologist, who had done the field work and prepared the report under agreement with the Survey.

OHIO.

In the Woodsfield and Summerfield quadrangles, Ohio, final field investigations of the structure of the oil sands in the Mississippian and Devonian strata have been made. A special effort has been made to procure logs and to ascertain the locations and elevations of wells in a number of pools, as the more accurate delineation of the structure of the deeper sands, made possible thereby, is proving to be of the greatest importance. The thorough study of the structure in these lower sands by R. V. A. Mills promises to show that in this region the segregation of the oil and gas in pools is strictly in accordance with the anticlinal theory. The contrary belief among many oil operators and many geologists is found to be due to an unusual lack of parallelism between the Pennsylvanian rocks, which crop out at the surface, and the underlying Mississippian and Devonian sands, on account of which the structure of the deep sands is imperfectly or even erroneously indicated by the structure of the exposed formations. Preliminary reports on the structure of the Berea oil sand in the Summerfield quadrangle (Bulletin 621–N) and in the Woodsfield quadrangle (Bulletin 621–O), both by D. D. Condit, have been published. In this work Mr. Condit has been assisted by Mr. Mills.

The structure of the Clinton sand in the vicinity of Wooster, in Wayne County, is described in a paper by C. A. Bonine, published as Bulletin 621–H.

The geology of the Columbus quadrangle is described and mapped in detail in Folio 197, which has been published during the year. In this folio, prepared by Profs. G. D. Hubbard, C. R. Stauffer, J. A. Bownocker (State geologist), and C. S. Prosser, through the courtesy of the State Geological Survey, unusual attention is given to the educational function of the Geologic Atlas.

In June the gas and oil developments in the vicinity of Cleveland were revisited by G. S. Rogers, and a report by him on the geologic structure of that area has been submitted for publication in "Contributions to economic geology."

Revised estimates of the original coal tonnage of Ohio have been carefully compiled by F. R. Clark for inclusion in the professional paper on the coal fields of the United States, in preparation under the direction of M. R. Campbell.

A report on the geology of the Steubenville and Cadiz quadrangles, by D. D. Condit, has been submitted for publication as a folio.

The field relation of the Cleveland and Huron shales to the Chagrin formation in the vicinity of Cleveland were studied by E. O. Ulrich and H. P. Cushing. The Cleveland folio, by Mr. Cushing and F. B. Van Horn, is now in process of revision by the authors.

The Hamilton and Mason quadrangles have been mapped in detail in previous years, and R. S. Bassler has practically completed his manuscript and maps for a folio covering this area, in association with Dr. N. M. Fenneman. The folio can not be finished, however, until certain features in the Cincinnati quadrangle are worked out by E. O. Ulrich.

OKLAHOMA.

In continuance of the investigations of the geologic structure and oil possibilities of different areas in Oklahoma both reconnaissance and detailed studies have been conducted, though on account of the reduced appropriation made by the State to its Geological Survey the cooperation of that organization consisted in courtesies and generously given information instead of the allotment of funds as in previous years.

The Foraker 15-minute quadrangle, lying in the Osage Nation along the Kansas line west of the Pawhuska quadrangle, was examined by K. C. Heald, and a report describing the structure and oil prospects of the area that has not yet been leased is now in press as Bulletin 641–B. Inspections of the outcropping formations and surface indications of structure in portions of the Osage Nation not yet topographically mapped were made by C. H. Wegemann and Mr. Heald.

The northern half of the Bristow quadrangle, which lies a few miles to the east of the Cushing pool, was examined in detail by A. E. Fath, who, notwithstanding the great difficulty of determining the geologic structure in the area, caused by local conditions, made very successful progress. A report on the area studied is now in preparation.

In connection with the investigation of the gas resources of the region potentially tributary to Fort Worth and Dallas, Tex., inspections and preliminary examinations were made by C. H. Wegemann of recent gas discoveries and of prospects along the southern border of the Oklahoma oil field, the prospects southwest of Muskogee, near Ada, being given special attention. Notes on this work by Mr. Wegemann were published in Bulletin 629.

The study of the structure, the areal geology, and the oil and gas developments in the Hominy 30-minute quadrangle was continued by R. H. Wood. The preparation of Mr. Wood's bulletin on the oil and gas structure of the quadrangle and of his report on the general geology is unfortunately delayed on account of errors in the elevations recorded in a part of the Hominy topographic sheet, and it is therefore probable that Mr. Wood's manuscript covering this quadrangle will not be completed before October.

The Healdton oil field, the Loco gas field, the Duncan gas field, and the Lawton oil and gas field, of which all except the first were examined with the cooperation of the State Geological Survey during the previous year, have been described in papers published, respectively, as parts B, C, D, and G of Bulletin 621. A report on the area lying between Beggs, Okmulgee, and Okemah, cooperatively examined in the same year, is now in preparation.

A manuscript for a bulletin by D. W. Ohern on the geology and economic deposits of the Nowata and Vinita quadrangles has been critically reviewed and is now in the hands of the author for final revision prior to publication.

The zinc and lead developments in the vicinity of Miami and Quapaw, in the Wyandotte quadrangle, were examined by C. E. Siebenthal, who procured data for inclusion in his reports on the Joplin district and in the folio for the Wyandotte quadrangle.

OREGON.

Maps and manuscripts for the geologic folio covering the Sumpter quadrangle, Oreg., the areal surveys for which were completed last year, were completed in part by J. T. Pardee. Reconnaissance examinations along the valleys of the South Fork of John Day River above Dayville and the Middle Fork of John Day River above Ritter were made by D. F. Hewett in June, 1915, and the results of these examinations will be included in the same folio. The principal routes of travel in an area 600 miles square were traversed. In July, 1915, a reconnaissance examination of deposits of volcanic ash along Umatilla River near Pendleton was made by Mr. Hewett.

About 50 square miles of the Riddles quadrangle, including the developments in copper and gold mining, were reviewed by J. S. Diller, who, with G. F. Kay, completed and submitted in January, 1916, the Riddles folio for publication.

A report on the Howard mining district, examined by G. F. Loughlin in a previous season, is in preparation.

Alkali Lake was visited and sampled by H. S. Gale with reference to the somewhat unusual potash content and the borax reported to occur in the brines which it contains.

Nitrate claims in the vicinity of Burns and near Placidia Butte and Wagontire Mountain, 40 to 60 miles southwest of Burns, were investigated by Mr. Gale and samples collected for analysis. A reported deposit near McDermitt, on the Oregon-Nevada State line, was also visited.

Abert Lake was examined and sampled by Mr. Gale with reference to the potash content of its waters, and he made a single traverse across the Malheur Lake basin and a traverse of the basins of the Mann and Alvord lakes, in the southern part of the State.

PENNSYLVANIA.

Some revisory study was accomplished by Miss Florence Bascom and E. T. Wherry in the Reading and Boyertown quadrangles, the text and maps for which are almost completed for transmission.

Mapping of the McCalls Ferry and Quarryville quadrangles was continued by Miss E. F. Bliss, who covered about 288 square miles in considerable detail. Some progress was made on the text and maps for the folio covering these quadrangles, which was begun by Prof. E. B. Mathews.

No further field work has been done in the Quakertown and Doylestown quadrangles. Prof. Bascom, the senior geologist on this project, has completed her field work, and some progress has been made on the text and maps for her portion of the folio covering these quadrangles.

In the Coatesville and West Chester quadrangles Prof. Bascom has been engaged in a revisory study of the gneisses. Work on the text and maps for the folio embracing these quadrangles is progressing well.

The mapping of the Paleozoic limestone formations in the New Cumberland, Harrisburg, Hummelstown, Middletown, and Lebanon quadrangles occupied G. W. Stose for a part of the field season, and the Paleozoic formations of central and southern Pennsylvania were reviewed by E. O. Ulrich and Charles Butts for the purpose of correlating the formations in several areas covered by folios recently published and in preparation.

Points in the Hollidaysburg, Huntingdon, and Bellefonte quadrangles and areas between and farther northeast were reexamined by Mr. Butts, who, in the Bellefonte quadrangle, conferred with Prof. E. S. Moore. The text and maps for the Huntingdon-Hollidaysburg folio are nearly completed by Mr. Butts.

Considerable progress on the text and maps for a folio covering the Fairfield and Gettysburg quadrangles, surveyed in previous years, was made by Mr. Stose and Prof. Bascom. The text for the historical geology and a section across the Triassic area were prepared by Mr. Stose.

The folio covering the Elkton and Wilmington quadrangles, by Prof. Bascom and B. L. Miller, has been transmitted for publication. These quadrangles include areas in Maryland and Delaware, and the folio was prepared in cooperation with the Maryland Geological Survey.

The Butler quadrangle was examined and mapped by G. B. Richardson, who covered the north half, and R. V. A. Mills, who studied the south half; and a report describing the structure and coal and oil resources is in preparation. Work was begun in June in the Zelienople quadrangle, in which Mr. Richardson was assisted by Prof. T. C. Brown.

Brief examinations in conference on the extramorainal drift in eastern Pennsylvania were held by W. C. Alden with Prof. Bascom and E. T. Wherry in the Reading quadrangle, with B. L. Miller in the Allentown quadrangle, with H. B. Kümmel in the Easton quadrangle. In western Pennsylvania Mr. Alden reviewed with G. B. Richardson Pleistocene deposits in the Zelienople and Warren quadrangles.

A paper on the relations of the Wissahickon gneiss to the Shenandoah limestone and Octŏraro schist of the Doe Run and Avondale region, Chester County, by Misses E. F. Bliss and A. I. Jonas, was published as Professional Paper 98-B.

RHODE ISLAND.

The geology of the islands off the south coast of Rhode Island was studied by J. B. Woodworth, and a report on them is in preparation.

A bulletin on Rhode Island coal, by G. H. Ashley, was published as Bulletin 615.

SOUTH CAROLINA.

The maps and manuscript for the folio covering the Kings Mountain and Gaffney quadrangles, which are mainly in South Carolina but include small areas in North Carolina, have been practically completed, and the material has been submitted for publication by D. B. Sterrett.

Some of the sericite rocks in North Carolina, South Carolina, and Georgia were examined by P. S. Smith, with the object of determining their potash content, purity, thickness, and accessibility. Samples for analysis were collected at many places in the vicinity of Blacksburg, S. C. A report of the investigation is in preparation by Mr. Smith.

Several weeks were spent by C. W. Cooke in field work on the Claiborne and Jackson formations of South Carolina, for the purpose of determining the age of the deposits of fuller's earth in Georgia and of establishing their correlation with formations in South Carolina.

Descriptions of the older Tertiary Bryozoa of the State are included in a general report, now almost completed, by F. Canu and R. S. Bassler.

SOUTH DAKOTA.

Maps and descriptions of the geology of the Deadwood, Harney Peak, Rapid, and Hermosa quadrangles, covering the greater part of the Black Hills, mapped on a scale of 1:125,000, were transmitted by N. H. Darton and Sidney Paige, Mr. Darton describing the Paleozoic and bordering younger sedimentary formations and Mr. Paige mapping and describing the pre-Cambrian geology and the mineral resources of the Black Hills. In response to a request from the Secretary of the Interior, a report was made on certain mining claims in the Harney National Forest by Mr. Paige.

Field studies of the Newell quadrangle were completed by Mr. Darton for the Newell folio, which is now in press.

Having accumulated new data regarding artesian prospects in western South Dakota, Mr. Darton prepared a report on artesian waters in the region adjoining the Black Hills, which will be published as a water-supply paper.

A report on the coal fields of northwestern South Dakota, by E. R. Lloyd, E. M. Parks, C. J. Hares, and D. E. Winchester, is in press as Bulletin 627.

TENNESSEE.

A geologic map of the Waynesboro quadrangle, Tenn., prepared by H. D. Miser, was transmitted for use in differentiating the formations in an adjoining area by the State Survey. The results of the studies by Mr. Miser will be embodied in the Waynesboro folio.

The areal mapping and structural determinations of parts of the Crossville quadrangle were revised by Charles Butts. A paper on the geologic structure with reference to oil and gas was prepared by Mr. Butts for publication by the State Survey, and a report on the coals of a portion of the quadrangle has been submitted by Mr. Butts, who also inspected the Mississippian and Silurian sections in the vicinity of Sparta and Nashville. During a part of the field work Mr. Butts was joined for conference by G. H. Ashley. These investigations were conducted in cooperation with the State.

The stratigraphic section of the Murfreesboro quadrangle was reviewed by E. O. Ulrich, for the purpose of determining the units to be mapped, and collections of early Paleozoic invertebrates for correlation were obtained by R. D. Mesler near Chattanooga, Wauhatchie, Carthage, Friendsville, White Pine, Dandridge, Whitesburg, and Midway.

The greensands in southern McNairy County were examined by G. H. Ashley, with special reference to their possible use in the production of potash, large percentages of which had been reported in earlier analyses. The beds were sampled and studied with reference to their extent, accessibility, and origin, as well as their potash content. A report by Mr. Ashley giving the results of the examination is now in preparation.

A report on the marble deposits of the State, based on work done in cooperation by the Bureau of Mines, the Bureau of Standards, the Office of Public Roads and Rural Engineering, the State Geological Survey, and the United States Geological Survey, is nearly complete. T. N. Dale, who for this Survey has sampled and examined the marbles mineralogically and petrologically, has finished his part of the work, which is ready to transmit for publication by the State Geological Survey. A summary of the work of Mr. Dale and of the areal geology by C. H. Gordon, assistant State geologist, will be included in a general report on the southern Appalachian marble deposits.

A report on the later Tertiary and Pleistocene history of the western part of the State is in preparation by E. W. Shaw. The erosion intervals in the Eocene of the Mississippi embayment are described in Professional Paper 95–F by E. W. Berry, and his monographic account of the old Eocene floras of the Coastal Plain is in press as Professional Paper 91.

Slight progress was made on a cooperative report describing the red iron ores of eastern Tennessee, northeastern Alabama, and northwestern Georgia, in preparation by E. F. Burchard, most of Mr. Burchard's time being demanded by other duties.

Chemical analyses made from samples collected by F. R. Clark at all the shipping coal mines of the State are published, with descriptive notes and sections, in Bulletin 621–P.

TEXAS.

At the request of the municipalities of Dallas and Fort Worth, Tex., that the Survey investigate the gas resources in the region tributary to these cities with special reference to the prospects for an adequate gas supply for the future, examinations were made in the autumn of 1915 of as large an area as could be studied, mapped, and described in a report to be published by January, the cost of the field work being cooperatively contributed by the two cities. The results of the work were, for the most part, issued in Bulletin 629.

In the Coastal Plain region the gas and oil fields of Limestone and Navarro counties were examined, and a report on the gas field in Limestone County by G. C. Matson was included in Bulletin 629. The oil and gas fields of this county will be more fully described in a report by Mr. Matson and O. B. Hopkins, which is now in preparation. The results of chemical examinations of the oils of Navarro County, based on samples submitted to the Bureau of Mines for examination, will also be incorporated in this publication. The oil and gas indications near Wortham, Currie, Richland, and Angus, in northern Limestone and southern Navarro counties, and at Mabank, Kaufman County, and Cash, Hunt County, were examined by Mr. Matson and described by him in Bulletin 629.

In the Paleozoic area the Strawn and Moran pools were studied and the structure of an area in the vicinity of Weatherford, Parker County, was mapped by H. M. Robinson and C. W. Hamman under the direction of E. W. Shaw. The Petrolia-Henrietta region was examined and mapped by Mr. Shaw, assisted by Mr. Robinson. Mr. Shaw made exploratory structural examinations in a large area north and west of Fort Worth. The results of these investigations are included in Mr. Shaw's contribution to Bulletin 629.

The reported oil and gas indications at Watauga, Tarrant County, and Baileyville, Milam County, were visited by O. B. Hopkins, and the area near Wolfe City, Hunt County, was examined by Mr. Hopkins and C. W. Hamman.

After a full test of the possibilities of discovering buried deposits of potash in the Smoke Creek Desert of western Nevada, the Survey drill outfit was shipped to the Panhandle of Texas as a region offering great promise in the Permo-Triassic "Red Beds" country of the Southwest. The studies by N. H. Darton of the stratigraphy, of the history of "Red Beds" deposition, and of the evidence of massive beds of gypsum, salt, and anhydrite in these rocks in New Mexico, Colorado, and Texas indicated a region of great precipitation of saline deposits in "Red Beds" time. A site near Cliffside, 7 miles northwest of Amarillo, Tex., was chosen by Mr. Darton and H. S. Gale in order to procure fuller and exact data as to the position, thickness, and richness of the beds that furnished crystals of potash salt and potash brines. The drilling at Cliffside was started late in the autumn; and on account of the exhaustion of the balance of the very small appropriation, already largely used in the work that had been carried on in Nevada, the work was stopped February 28, 1916, when the hole had reached a depth of 362 feet and before the salt beds, which should be found at intervals between 750 and 2,300 feet, had been encountered. The work will be continued in the next fiscal year.

Supplementary field studies along the zone of an uplift, including Denison and extending eastward in northeastern Texas, were made by L. W. Stephenson to correct errors in the previous geologic mapping of the Cretaceous formations of the area and to ascertain with greater accuracy the age relations of these formations. The geologic structure in Grayson County near Sherman and Fannin County near Bonham was examined by Mr. Stephenson and will be made the subject of a bulletin. Several reports were made by Survey paleontologists on small referred collections from Texas, and the floras of Jackson and Claiborne age have been described in a paper in preparation by E. W. Berry.

A report on the geology of the Coastal Plain of Texas west of Brazos River, by Alexander Deussen, has been completed and submitted for publication. The ground waters of Lasalle and McMullen counties have been described by Mr. Deussen and R. B. Dole in Water-Supply Paper 375–G.

The iron ores in Cass, Marion, Morris, and Cherokee counties are discussed in Bulletin 620–E by E. F. Burchard.

A report on the geography and geology of the trans-Pecos region, by R. T. Hill, is under revision by the author with special reference to recent progress in the definition of physiographic provinces in the United States.

The results of examinations of the geologic structure and oil and gas prospects in a part of Palo Pinto County and near Quanah in Hardeman County, by C. H. Wegemann, have been printed in parts E and J, respectively, of Bulletin 621.

UTAH.

The general summary report on the ore deposits of Utah, by B. S. Butler and G. F. Loughlin, field studies for which have been in progress for two or more seasons, was submitted for publication in May, 1916.

Newly discovered zinc deposits in the Promontory Range, examined in September, 1915, by Mr. Butler and V. C. Heikes, are described in a brief report issued as Bulletin 640–A and entitled "Notes on the Promontory district, Utah."

A reconnaissance report on the Cottonwood-American Fork mining region, by Messrs. Butler, Loughlin, and Heikes, was published late in 1915 as Bulletin 620–I. A thorough study of this region is now in progress.

The report on the geology and ore deposits of the Tintic district, revisited by Waldemar Lindgren and Mr. Loughlin in 1914, has been transmitted for publication.

A reexamination of the alunite deposits at Marysvale, made by Mr. Loughlin and H. S. Gale in response to a special request from mining men, resulted in the publication of Bulletin 620–K, "Recent alunite developments near Marysvale and Beaver, Utah," by Mr. Loughlin.

The reconnaissance report on the Navajo country, covering parts of Arizona, New Mexico, and Utah, by H. E. Gregory, has been transmitted for publication as Professional Paper 93.

The deposits of ozokerite in central Utah are described in Bulletin 641–A by H. M. Robinson.

Geologic folios and economic reports for the Sunnyside, Wellington and Castlegate quadrangles, which embrace the most important part of the Book Cliffs coal field, are in preparation by F. R. Clark, who has also made some progress in the preparation of an economic report on the Lost Creek coal field.

Further examinations of the deposits of oil shale in northeastern Utah were made by D. E. Winchester, who made more exact as well as more numerous field tests than had been possible with the apparatus used by Messrs. Day and Woodruff. Advance notices of the richness of some of these extensive deposits and of the enormous reserve of oil, gasoline, and other hydrocarbon products which they contain were issued during the winter. A preliminary report of the results of the investigations by Mr. Winchester is in press as Bulletin 641-F.

A report on the geology and coal resources of Castle Valley, Carbon, Emery, and Sevier counties, by C. T. Lupton, has been published as Bulletin 628.

Data for a report on the building stones of Utah are being accumulated by G. F. Loughlin.

A statement concerning potash in the Salduro Marsh was prepared by H. S. Gale and submitted to the Engineering and Mining Journal for publication.

An examination of the Mississippian phosphate deposits and of the stratigraphy in the Logan quadrangle was made by E. H. Finch, and township reports were submitted to the land-classification board. Phosphate beds in northern Utah were mapped by A. R. Schultz, who also made a preliminary examination of the geology and structure of the Uinta Range.

VERMONT.

The areal survey of the Bennington quadrangle, Vermont, was continued by L. M. Prindle, about 40 square miles being covered, principally in the pre-Cambrian rocks. This quadrangle, together with the Hoosick quadrangle, N. Y., will be described in a folio, the text and maps for which are nearing completion.

In the field Prof. T. N. Dale continued his traverse of the area between the pre-Cambrian gneiss and the Cambrian schist and quartzite in the Londonderry, Wallingford, Ludlow, Townshend, and Rutland quadrangles, about 40 square miles being studied. The results of this work were embodied in a paper, "Notes and map of the pre-Cambrian boundary east of the Green Mountain axis," which was submitted for publication. Prof. Dale also completed his catalogue of 2,626 thin sections made in connection with his work in Vermont quadrangles during past field seasons.

The special investigation of the stratigraphy and faulted structure of the Taconic Mountains in the Castleton and Pawlet quadrangles was continued by Arthur Keith for the purpose of solving certain intricate problems there before the western Vermont folios can be published.

The study of the pre-Cambrian formations and structure and the detailed areal mapping in the Rutland quadrangle was continued by Mr. Keith, who made a detailed survey of the West Rutland marble district, in the Castleton quadrangle.

Detailed geologic mapping along the south border of the Rochester quadrangle was begun by Mr. Keith, and he also made reconnaissance examinations of the Devonian rocks in the Brattleboro quadrangle and of the pre-Cambrian rocks in the Ludlow, Wallingford, Woodstock, and Rochester quadrangles.

A manuscript describing the Quaternary geology of the Hoosic and Bennington quadrangles was completed by F. B. Taylor.

A brief study of the glacial phenomena in the Cambridge, Equinox, and adjacent quadrangles was made in June by W. C. Alden and Mr. Taylor.

VIRGINIA.

As the result of brief visits to manganese mines in Virginia and Maryland during 1913, 1914, and 1915, a report entitled "Some manganese deposits of Virginia and Maryland" was prepared by D. F. Hewett for publication as Bulletin 640–C. In this report Mr. Hewett shows a probable relation between the deposition of the ores and the physiographic history of the region.

The detailed mapping and description of the southwestern Virginia coal field, which have for two years been in progress under the immediate direction of Henry Hinds, were carried on during the season by Mr. Hinds, assisted by T. K. Harnsberger. The mapping of the quadrangles was completed, and in June, 1916, field work in Buchanan County was resumed and nearly completed. During the office season a report on the coal resources of the Clintwood and Bucu quadrangles was prepared by Mr. Hinds and transmitted to the State, and it is now in press.

A report on the salt and gypsum of southwestern Virginia, for publication by the State Survey, was prepared by G. W. Stose and submitted to the State geologist. The folio on the Abingdon quadrangle is to be prepared by Mr. Stose in association with Arthur Keith.

A paper on the gypsum deposits in southwestern Virginia by Mr. Stose was revised and transmitted for publication by the Survey.

The greensands on Potomac River at Aquia Creek were examined by G. H. Ashley and sampled for analysis and study with special reference to their potash content.

The Silurian and Devonian formations near Big Stone Gap were studied and paleontologic collections obtained from them by E. O. Ulrich, assisted by T. E. Williard. Paleozoic invertebrate fossils were collected near Wytheville and Mount Sidney by R. D. Mesler.

A report on the Tertiary invertebrates of the State is almost complete. The Miocene flora at Richmond is described by E. W. Berry in Professional Paper 98–F.

WASHINGTON.

A reconnaissance report on the Conconully and Ruby mining districts, Wash., by E. L. Jones, jr., has been issued as Bulletin 640–B. Mr. Jones also prepared and submitted classification reports on lands in contest between homestead and mining claimants in T. 40 N., Rs. 29 and 30 E. Willamette meridian.

The manuscript for a bulletin entitled "The mineral deposits of the Colville Indian Reservation," begun in the preceding year, was completed by J. T. Pardee.

Text to accompany the map of Mount Rainier National Park was submitted by F. E. Matthes.

WEST VIRGINIA.

Office work on the maps and description of the Williamsport quadrangle, in West Virgina, Maryland, and Pennsylvania, has been advanced by G. W. Stose for the Williamsport-Hagerstown folio. The work is being done in cooperation with the State of Maryland.

WISCONSIN.

A folio for the Wausau and Marathon quadrangles, Wis., is now being prepared by Dr. Samuel Weidman under agreement, the field examinations of these quadrangles having been made, in cooperation, by the State Geological and Natural History Survey.

WYOMING.

Field work in the Bighorn Basin, Wyo., which was begun in June, 1914, was continued by C. T. Lupton in 1915. Mr. Lupton was assisted, in part or all of the field work, by M. W. Ball, R. H. Wood, E. M. Parks, W. B. Emery, and C. J. Hares. The work consisted in the examination of all the anticlines in the basin, in order to determine which have most promise of containing oil or gas. The territory surveyed embraced an area of about 680 square miles. This work, together with that done by Mr. Lupton the previous year and by D. F. Hewett, covered the entire southern two-thirds of the Bighorn Basin. Upon Mr. Lupton's return to the office it was decided to combine all the reports on anticlines in the basin into one paper, of which he is principal author. This report, in which the descriptions of the anticlines in the Oregon Basin and the Ilo and Meeteetse quadrangles are contributed by Mr. Hewett, has been submitted and is undergoing critical examination.

Areal geologic work in the Hanna coal field was continued by C. F. Bowen, who, with the assistance of H. M. Robinson and C. J. Hares, mapped in great detail the Saddleback Hills quadrangle and a part of the Hanna quadrangle, an area of about 500 square miles. In addition, Mr. Bowen made a special examintion of T. 19 N., R. 77 W., to classify the land. In the office Mr. Bowen has been engaged in preparing geologic folios and economic reports on the Walcott, Hanna, and Saddleback Hills quadrangles and in preparing data for the classification and valuation of the lands.

Mr. Hares prepared a preliminary report on anticlines in central Wyoming, which is now in press as Bulletin 641-I. A general report on the same region, which will describe fully the formations and discuss their probable correlations with formations in adjacent fields, will be ready for publication early in the following year.

A report on prospects for oil and gas near Basin, Big Horn County, by Mr. Lupton, has been published as Bulletin 621-L.

The examination of the Powder River coal field, which was begun in June, 1915, was continued by C. H. Wegemann, assisted by R. W. Howell, and extended to include the Salt Creek oil field. Mr. Howell assumed general charge of the coal work, and Mr. Wegemann of the oil work. The area of the coal field examined is 1,900 square miles. The parts where coal beds were found were examined in great detail, but other parts were surveyed only in reconnaissance. Mr. Howell spent the winter in preparing data for land classification and valuation and in writing an economic report for publication. This work is well advanced. Mr. Wegemann made a very detailed reexamination of the Salt Creek oil field, and his report on it is now nearly ready for critical review.

Phosphate beds at several localities in Wyoming, Colorado, and Utah were examined by A. R. Schultz, who made a preliminary study of the geology and structure of the Uinta Range.

Fourteen township reports and a general report on the phosphate of the Owl Creek Mountains region have been completed by D. D. Condit and transmitted to the land-classification board.

A report on the flora of the Frontier formation by F. H. Knowlton has been submitted for publication, and a "Note on the discovery of fossil plants in the Morrison formation" of the Bighorn Basin, by the same paleontologist, has been published unofficially. A study of the Bighorn limestone and its fauna was continued by Edwin Kirk both in the field and in the laboratory.

The Cretaceous and Tertiary section of the Hanna and Saddleback Hills quadrangles was reviewed by T. W. Stanton under the guidance of C. F. Bowen.

Reports on reconnaissance examinations of ore deposits in the Atlantic gold district and the North Laramie Mountains, by A. C. Spencer, were published during the year as Bulletin 626. To this bulletin N. H. Darton contributed a chapter on the sedimentary formations and a geologic map of part of central Wyoming.

Some progress was made by Arnold Hague in the description of the geology of the Yellowstone National Park.

Office work was continued by G. R. Mansfield on the Montpelier, Slug Creek-Crow Creek, and Lanes Creek-Freedom folios, covering quadrangles in Wyoming and Idaho.

The results of chemical experiments by R. C. Wells relating to the extraction of potash from the wyomingite of the Leucite Hills are described in Professional Paper 98–D.

CANAL ZONE.

A bulletin entitled "Some engineering problems of the Panama Canal," by D. F. MacDonald, was completed and published as Bulletin 86 of the Bureau of Mines. Progress was made in the preparation of a report on the geography and geology of Panama by Mr. MacDonald, who also cooperated with the committee from the National Academy of Sciences appointed at the request of the President to study and report on the Panama Canal slide problem. Whitman Cross and G. F. Becker, geologists, were members of this committee. Mr. Becker submitted a short paper entitled "Mechanics of the Panama Canal slides," to be published as Professional Paper 98–N.

A report upon the Foraminifera of the Canal Zone, exclusive of the orbitoids and nummulitids, was completed and submitted by J. A. Cushman, who is now making a special study of the larger orbitoid species and genera from that area.

WEST INDIES.

A report on some Cenozoic Mollusca of the West Indies was completed by C. W. Cooke. This paper will be published by the Carnegie Institution. Other reports on Antillean paleontology completed during the year discuss the calcareous algae, by M. A. Howe; the Bryozoa, by R. S. Bassler and F. Canu; and the Crustacea, by Miss M. J. Rathbun. Reports on the geology and geologic history of Cuba, by T. W. Vaughan, O. E. Meinzer, and others, and on the geology and geologic history of the Windward Islands, by R. T. Hill and Mr. Vaughan, are almost complete. The Survey has been at no expense for the work of Messrs. Howe, Bassler, Canu, and Hill and Miss Rathbun. Papers on the shore-line features and the corals and coral reefs by T. W. Vaughan were published unofficially during the year.

DIVISION OF ALASKAN MINERAL RESOURCES.

APPROPRIATION AND CLASSES OF WORK.

Under the appropriation of $100,000 made for the continuation of the investigation of the mineral resources of Alaska, as in previous years, work of the following classes was carried on: Reconnaissance and detailed geologic surveys, special investigations of mineral resources, reconnaissance and detailed topographic surveys, investigations of water resources, and collection of statistics on mineral production.

PERSONNEL.

On July 1, 1915, the personnel of the division consisted of 1 geologist in charge, 11 geologists, 4 topographers, 1 engineer, 3 clerks, and 1 draftsman on annual salaries, 1 clerk on monthly salary, 2 geologists on per diem salary, 1 field assistant, and 28 camp hands and recorders. On June 30, 1916, the personnel included 1 geologist in charge, 11 geologists, 4 topographic engineers, 1 hydraulic engineer, 3 clerks, and 1 draftsman on annual salaries. The field force also included 1 assistant and 31 camp hands and recorders.

FIELD WORK DURING THE SEASON OF 1915.

Areas covered and allotments.—Twelve parties were engaged in surveys and investigations during 1915. The area covered by reconnaissance geologic surveys, on a scale of 1:250,000 (4 miles to the inch), amounts to 10,700 square miles; by detailed geologic surveys, on a scale of 1:62,500 (1 mile to the inch), 200 square miles. Much of the time of the geologists was devoted to the investigation of special field problems in the important mining districts, the results of which can not be presented in terms of area. About 10,400 square miles was covered by reconnaissance topographic surveys on a scale of 1:250,000, and 12.5 square miles on a scale of 1:24,000 (2.64 inches to 1 mile).

The following table shows the allotment, including both field and office expenses, of the total appropriation to the districts investigated. In addition to this, a balance of about $11,000 from last year's appropriation was expended in equipping the parties for the season's field work. In preparing this table the general office expenses were divided among the districts in a proportion determined by the cost of the surveys in each district, allowance being made for variations in the character of the work. The results are expressed in round numbers. The "general investigations" include the cost of special studies of geology and mineral resources which were not of an areal character. The balance has been used for equipment of field parties and expenses of the season of 1916.

Approximate geographic distribution of appropriation for Alaska investigations, 1915–16.

Southeastern Alaska	$16,300
Copper River	10,400
Prince William Sound	5,000
Cook Inlet region	13,500
Yukon and Kuskokwim basins	40,500
General investigations	8,300
Allotted to field work, 1916	6,000
	100,000

In the following table the approximate amount of money devoted to each class of investigations and surveys is indicated. It is not possible to give the exact figures, as the same party or even the same men may have carried on different kinds of work, but this statement will serve to elucidate a later table, which will summarize the complete areal surveys.

Approximate allotments to different kinds of surveys and investigations, 1915–16.

Reconnaissance geologic surveys	$28,000
Detailed geologic surveys	3,800
Special geologic investigations	9,600
Reconnaissance topographic surveys	26,000
Detailed topographic surveys	3,000
Investigations of water resources	5,000
Collection of mineral statistics	1,300
Miscellaneous, including administration, inspection, clerical salaries, office supplies and equipment, and map compilation	17,300
Allotted to field work, 1916	6,000
	100,000

Allotments for salaries and field expenses.

Scientific and technical salaries	$35,918
Field expenses	42,332
Clerical and other office and miscellaneous expenses	15,750
Allotted to field work, 1916	6,000
	100,000

The following table exhibits the progress of investigations in Alaska and the annual appropriations since systematic surveys were begun in 1898. It should be noted that a varying amount is spent ach year on special investigations yielding results which can not e expressed in terms of area:

Progress of surveys in Alaska, 1898–1915.

Field season.	Appropriations.	Areas covered by geologic surveys.			Areas covered by topographic surveys.[a]					Investigations of water resources. Gaging stations maintained part of year.
		Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000).	Detailed (scale 1:62,500).	Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000; 200-foot contours).	Detailed (scale 1:62,500 and larger; 25, 50, or 100 foot contours).	Lines of levels.	Bench marks set.	
		Sq. m.	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Miles.*		
898	$46,189	9,500			12,840	2,070				
1899	25,000	6,000			8,690					
1900	60,000	3,300	6,700		630	11,150				
1901	60,000	6,200	5,800		10,200	5,450				
1902	60,000	6,950	10,050		8,330	11,970	96			
1903	60,000	5,000	8,000	96		15,000				
1904	60,000	4,050	3,500		800	6,480	480	86	19	
1905	80,000	4,000	4,100	536		4,880	787	202	28	
1906	80,000	5,000	4,000	421		13,500	40			14
1907	80,000	2,600	1,400	442		6,120	501	95	16	48
1908	80,000	2,000	2,850	604		3,980	427	76	9	53
1909	90,000	6,100	5,500	450	6,190	5,170	444			81
1910	90,000		8,635	321		13,815	36			69
1911	100,000	8,000	10,550	496		14,460	246			68
1912	90,000		2,000	525			298			69
1913	100,000	3,500	2,950	180	3,400	2,535	287			
1914	100,000	1,000	7,700	325	600	10,300	10			
1915	100,000		10,700	200		10,400	12	3	2	9
	1,361,189	73,200	94,435	4,596	51,680	137,280	3,664	462	74	
Percentage of total area of Alaska		12.48	16.10	.78	8.81	23.41	.62			

[a] The Coast and Geodetic and International Boundary surveys and the General Land Office have also made topographic surveys in Alaska. The areas covered by these surveys are of course not included in the totals given here.

General work.—Alfred H. Brooks, geologist in charge, was engaged in office work until July 9, when he started for Alaska. He visited the Canfield party in southeastern Alaska and devoted 10 days to a study of the geology and mineral resources of the Iditarod district, 5 days to the Hot Springs district, and 16 days to the Fairbanks district. In this work special attention was paid to antimony deposits. Returning, he reached Washington October 14. In Mr. Brooks's office work 54 days were devoted to geologic investigations, 24 days to reading and revising manuscripts, 17 to writing articles for the annual progress report, 7 to preparing the annual press bulletin on mining developments in Alaska, 7 to mineral statistics, and 10 to field plans. The rest of his time was devoted to routine and miscellaneous matters.

To G. A. Waring was assigned the task of making a reconnaissance of the more accessible mineral springs of Alaska. He carried on field work in southeastern Alaska from June 15 to July 2, in the Yukon basin from July 10 to August 17, and in Seward Peninsula from August 28 to September 9. During this time he investigated 18 hot and 5 other springs and collected 27 samples of surface waters.

G. C. Martin and A. G. Maddren were engaged the entire year in office work. This respite from field work was necessary owing to the accumulation of a large amount of field data which had not been completely worked up. Mr. Martin was occupied chiefly in continuing his studies of the Mesozoic stratigraphy of Alaska; Mr. Maddren was employed in preparing reports on the lower Kuskokwim region and on the international boundary region of northwestern Alaska.

Arthur Hollick was employed for six weeks in continuing the preparation of his report on the Cretaceous and Tertiary floras of Alaska.

R. H. Sargent continued the general supervision of the Alaska topographic surveys and map compilation, in addition to carrying on his own field work.

E. M. Aten continued as office assistant to the geologist in charge and supervised the office work during Mr. Brooks's absence in the field. He also continued to assist in collecting statistics of the production of precious metals in Alaska.

Southeastern Alaska.—The detailed topographic survey of the region adjacent to Juneau was continued by D. C. Witherspoon. Field work was begun on May 12 and continued, so far as weather permitted, until October 7. The large scale adopted for this base map (1:24,000, or about 2.64 inches to the mile), the rugged character of the country, and the rank and prickly vegetation all combine to make the work exceedingly difficult. In spite of the adverse conditions Mr. Witherspoon completed the mapping of some 12.5 square miles. He also occupied 16 triangulation stations, ran 3 miles of levels, and set 2 permanent bench marks.

The systematic geologic survey of the Ketchikan district, begun in 1913 but interrupted in 1914, was continued in 1915 by Theodore Chapin. He began field work, using a gasoline launch for transportation, on May 16 and continued it until October 23, covered about 420 square miles, and also made special investigations of the mineral resources.

Under a cooperative agreement with the Forest Service the investigation of the water powers of southeastern Alaska was begun in 1915. G. H. Canfield, who had charge of this work, established his headquarters at Ketchikan in May and continued the water measurements to the close of the fiscal year 1916. Eight automatic gaging stations and one other were installed, in addition to which many miscellaneous measurements were made. Records of stream flow will have to be obtained through a period of years before accurate data on run-off are available. Meanwhile the records thus far obtained are not without value, and these are summarized elsewhere in this volume. Many members of the Forest Service have aided in this work, but special acknowledgment should be made to W. G. Weigle, supervisor at Ketchikan, and to Leonard Lundgren, district engineer at Portland, Oreg.

Copper River region.—F. H. Moffit, assisted by R. M. Overbeck, made a geologic reconnaissance of the upper Chitina River basin. A journey was made with pack train up the north side of the Chitina Valley to a point within 10 miles of the international boundary. Field work began on June 20 and ended September 25, and a geologic reconnaissance of about 900 square miles was completed. The topographic map made by the International Boundary Commission was used as a base and was supplemented by topographic reconnaissance surveys of an adjacent area of about 360 square miles.

Prince William Sound.—The detailed geologic survey and study of the mineral resources of the Port Valdez district, begun in 1914, was completed in 1915 by B. L. Johnson. He began field work on June 5 and continued it until October 25, covering about 200 square miles.

Cook Inlet-Susitna region.—J. W. Bagley devoted the early part of the season to extending a topographic reconnaissance north of the previously mapped areas in the Talkeetna Mountains and surveyed an area of 835 square miles. In addition to this he surveyed an area of 150 square miles in the Turnagain-Knik region. Mr. Bagley, using pack-train transportation, started his field work on June 6 and continued it until September 5. In the early part of the season his surveys were much hampered by the smoke of forest fires, and later he lost nearly three weeks because of the nondelivery of supplies, which, however, was due to an accident and not to the delinquency of the contractor.

S. R. Capps, with a pack train and two men, studied the geology of the Turnagain-Knik region, investigating the geology of an area of about 1,200 square miles. The field work extended from June 14 to September 12, and about a week of this time was spent in investigating the mining developments of the Willow Creek district.

Yukon-Kuskokwim region.—Eliot Blackwelder devoted the months of June, July, and August to stratigraphic studies in the upper Yukon Basin. The work was done by a boat trip from Eagle to Circle and thence with pack train to the White Mountains, 100 miles to the southwest. Mr. Blackwelder returned to the Yukon by raft down Beaver and Birch creeks and made traverses of those streams, whose courses through the flats were previously unknown.

H. M. Eakin made an exploration of the Cosna-Nowitna region. He left the mouth of Cosna River—a southern tributary of the Tanana—with a pack train on June 16 and carried a geologic and topographic exploratory survey northwestward to the Nowitna. Here the horses were shot, and the party continued the journey to the Yukon on a raft, arriving there September 3. Though he had no technical assistance, Mr. Eakin made geologic exploratory surveys of an area of 2,600 square miles and topographic surveys of an area of 3,000 square miles.

A large area was also surveyed in the region including the Ruby district on the north and Iditarod on the southwest and extending southeastward to the mouth of Takotna River, a tributary of the Kuskokwim. The northern party in this field, which included C. E. Giffin, topographic engineer in charge, with G. L. Harrington as geologist, covered some 2,400 square miles by geologic and topographic reconnaissance surveys, besides revising the old surveys of some 1,600 square miles. The traveling was done by pack train, and the field season extended from June 11 to September 11. R. H. Sargent, topographic engineer, had charge of the southern party, with J. B. Mertie, jr., as geologist, and worked from June 13 to September 7. This party made topographic and geologic reconnaissance surveys of 3,520 square miles, besides revising the previous surveys of 490 square miles.

FIELD WORK FOR THE SEASON OF 1916.

Field parties began work before the end of the fiscal year with the following plans: Theodore Chapin during part of May and the whole of June continued the geologic mapping and study of mineral resources of the Ketchikan district, in southeastern Alaska. D. C. Witherspoon during the later part of May and the whole of June was completing the preparation of a detailed base map of the vicinity of Juneau, and the study of the geology and mineral resources of the same area is to be undertaken later by A. C. Spencer and H. M. Eakin. Mr. Eakin spent a part of the month of June in a study of the Porcupine placer district. G. H. Canfield from January throughout the year has continued the investigation of the water powers of southeastern Alaska in cooperation with the Forest Service. F. H. Moffit during part of June was engaged in some supplementary investigations of the Kotsina-Chitina copper belt. The geology and mineral resources of the southwestern part of the Prince William Sound copper-bearing region were investigated during part of June by B. L. Johnson. During June J. W. Bagley was making a topographic base map (scale 1:250,000) of the northern part of Prince William Sound. J. B. Mertie, jr., was detailed to investigate the Tolovana placer district in June and later to make some supplementary studies of the lodes of the Fairbanks and Nome districts. A detailed geologic survey of the western part of the Nenana coal ield is being carried on by G. C. Martin, A. G. Maddren, and R. M. Overbeck. This work was started in June. S. R. Capps and C. E. Giffin in June made geologic and topographic reconnaissance surveys of the Kantishna district and adjacent region. A topographic and geologic reconnaissance survey of the lower Yukon, including the Marshall placer district, was begun in June by R. H. Sargent and G. L. Harrington. All the above-mentioned pieces of work will continue into the fiscal year 1916–17.

COLLECTION OF STATISTICS.

The work of collecting statistics of the annual production of gold, silver, and copper, begun in 1905, was continued during the year. Preliminary estimates of mineral production were published on January 1, 1916. The progress report for 1915 (Bulletin 642), containing figures on mineral production, was transmitted in April.

PUBLICATIONS.

During the year three separates of professional papers (95–D, 95–H, and 98–C), five bulletins (Nos. 587, 605, 607, 608, and 622), and one water-supply paper (No. 372) relating to Alaska were issued. One general map of Alaska (No. C, scale 1:12,000,000) was issued for sale.

Four bulletins (Nos. 630, 631, 642, and 649) were in press at the end of the year. Manuscripts of the following reports have been completed: "Mineral springs of Alaska" (Water-Supply Paper 418), by G. A. Waring; "The Nelchina-Susitna region," by Theodore Chapin; "The upper Chitina Valley," by F. H. Moffit; "The Cosna-Nowitna region," by H. M. Eakin; "The panoramic camera in topographic surveying," by J. W. Bagley; "The Lake Clark-central Kuskokwim region," by P. S. Smith; and "The Canning River region of northern Alaska," by E. de K. Leffingwell.

The following reports are in hand:

Geology of the Glacier Bay and Lituya region, Alaska, by F. E. and C. W. Wright.

Geology of the region along the international boundary from Porcupine River to the Arctic Ocean, by A. G. Maddren.

The upper Matanuska basin, by G. C. Martin.

The Kotsina-Kuskulana district, by F. H. Moffit.

The lower Kuskokwim region, by A. G. Maddren.

The Yakataga district, by A. G. Maddren.

The Mesozoic stratigraphy of Alaska, by G. C. Martin.

The Valdez district, by B. L. Johnson.

The Ruby-Kuskokwim region, by J. B. Mertie, jr., and G. L. Harrington.

The Cretaceous and Tertiary floras of Alaska, by Arthur Hollick.

A Lower Jurassic flora from the upper Matanuska Valley, Alaska, by F. H. Knowlton.

Office work on the three maps listed below, besides the general map of Alaska noted above, has been completed:

Lower Kuskokwim region, by A. G. Maddren; scale, 1:500,000; contour interval, 500 feet.

Lake Clark-Kuskokwim region, by R. H. Sargent; scale, 1:250,000; contour interval, 200 feet.

Mineral resources of Alaska (new edition), by A. H. Brooks; scale, 1:5,000,000.

The following topographic maps are on hand:

Kotsina-Kuskulana district, by D. C. Witherspoon; scale, 1:62,500; interval, 100 feet.

Nelchina-Susitna region, by J. W. Bagley; scale, 1:250,000; contour interval, 200 feet.

Juneau mining district, by D. C. Witherspoon; scale, 1:24,000; contour interval, 50 feet.

Yukon-Tanana region (compiled); scale, 1:500,000; contour interval, 500 feet.

Ruby-Kuskokwim region, by R. H. Sargent; scale, 1:250,000; contour interval, 200 feet.

Cosna-Nowitna region, by H. M. Eakin; scale, 1:250,000; contour interval, 200 feet.

Matanuska region, by J. W. Bagley; scale, 1:250,000; contour interval, 200 feet.

Turnagain-Knik region, by J. W. Bagley; scale, 1:250,000; contour interval, 200 feet.

SCIENTIFIC RESULTS.

Many important scientific results relating to problems of stratigraphy, structure, physiography, etc., are achieved each year incidentally to the areal mapping, but these need no special mention. Mr. Blackwelder's stratigraphic studies in the White Mountains of the Yukon-Tanana region show that the oldest fossiliferous rocks are probably Upper Cambrian, and these are succeeded by argillites and quartzites overlain conformably by Ordovician volcanic rocks. The next higher formation is made up of limestones and volcanic rocks (Ordovician or Silurian), and this is conformably overlain by 1,200 to 2,000 feet of massive dolomite, with some quartzite and conglomerate. The most important feature of this work is the determination that the massive dolomite and limestones are of Silurian age and not Ordovician-Devonian, as previously supposed; also that the sequence of lower Paleozoic rocks, ranging from Cambrian to Silurian in age, measures from 6,500 to 7,500 feet in thickness. In the upper Chitina Valley Mr. Moffit found an extensive development of Carboniferous or older rocks overlain by Triassic limestones and shales, succeeded by Upper Jurassic sandstones. The top of the bedrock section consists of over 5,000 feet of conglomerates, sandstones, and shales, of which at least the lower 3,000 feet can be definitely assigned to the Cretaceous. The fossils indicate that these rocks belong either in the upper part of the Lower Cretaceous or in the lower part of the Upper Cretaceous.

Messrs. Mertie and Harrington's investigations of the gold deposits of the Ruby-Iditarod region indicate that there were two epochs of mineralization in this province. The younger was definitely connected with monzonitic intrusions, probably Eocene, which invaded sediments of Upper Cretaceous age. The older is probably genetically related to Mesozoic intrusions. Mr. Brooks in his study of the Alaska stibnite deposits found considerable evidence that the antimony mineralization is connected with intrusions of Eocene age. These conclusions are subject to revision, but the evidence in hand indicates that in Alaska there were two epochs of important metallization. One of these is Mesozoic (Upper Jurassic or Lower Cretaceous) and the other Eocene. Both are genetically related to igneous intrusions. The irregularity in distribution of the Tertiary mineralization may be accounted for by the irregularity in distribution of the Eocene intrusive rocks, which in turn is the result of the localized character of the Eocene deformation, the Eocene intrusives being abundant only where the rocks have been much deformed and absent where they are little disturbed.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

In the chemical laboratory 339 quantitative analyses and 1,446 qualitative determinations of rocks and minerals were reported during the year, the samples tested consisting chiefly of minerals sent for inspection by citizens.

F. W. Clarke, in cooperation with W. C. Wheeler, continued his research on the inorganic constituents of marine invertebrates, and the manuscript reporting the results of the investigation is now ready for publication as Professional Paper 102. Some work was done on the revision of fundamental atomic weights. In February Mr. Clarke, at the request of the Treasury Department, served as a member of the annual Assay Committee.

George Steiger, in cooperation with E. S. Larsen, analyzed a new mineral, which was named sulphatic cancrinite, and wrote a description of it that was published unofficially. He also prepared a note on the action of ammonium chloride and of hydrochloric acid on muscovite for Bulletin 620–J. During the summer and fall Mr. Steiger devoted considerable time to the exhibit of the United States Geological Survey for the National Exposition of Chemical Industries. He has also had charge of the administrative work of the section of chemistry since February.

W. T. Schaller devoted practically all his time to routine work, consisting of miscellaneous chemical and mineralogic determinations. His "Mineralogic notes, series 3" (Bulletin 610), was published during the year. He has continued work on Professional Paper 92, "The gem tourmaline fields of southern California," and on two other reports, "Mineralogic notes, series 4," and "The mold of the zeolite region of New Jersey." In March Mr. Schaller was assigned to the preparation of the annual reports on the production of gems and precious stones, mica, monazite, thorium, and zircon.

In the course of his routine analytical work, R. C. Wells, physical chemist, made analyses of the rare minerals plumbojarosite, bismutite, and gearksutite, from new localities, and of two new minerals—a bismuth arsenate, which has been named arseno-bismite, from Tintic, Utah, and a fluorine mineral, which has been named creedite, from Colorado. Mr. Wells prepared the following papers during the year: "The solubility of magnesium carbonate in natural waters," published in the Journal of the American Chemical Society; "The solubility of calcite in water in contact with the atmosphere, and its variation with temperature," published in the Journal of the Washington Academy of Sciences; "The fractional precipitation of some ore-forming compounds at moderate temperatures" (Bulletin 609); and "Experiments on the extraction of potash from wyomingite" (Professional Paper 98–D). During February, March, and April Mr. Wells was absent on leave without pay making chemical investigations connected with certain reported potash deposits near the west coast of South America.

Most of R. K. Bailey's time was taken up with routine work, consisting of both quantitative and qualitative analyses, but he was employed one hour a day in assisting Survey geologists in making laboratory experiments. Mr. Bailey was engaged for four months drilling test holes at Cliffside, Tex., in search of potash. His work consisted in taking samples and making field tests.

A. A. Chambers was assigned from the water-resources branch to the division of chemical and physical research for half time on January 16 and for full time on April 16, 1916. His time was taken up entirely with routine work in both qualitative and quantitative analyses.

W. B. Hicks attended to the drilling, sampling, and chemical work of the test holes sunk in Smoke Creek Desert, Nev., in search of potash, from July to October. He prepared for publication "Evaporation of brines from Searles Lake, Cal." (Professional Paper 98–A); "Some simple tests for potash," for the annual potash report; and "Some simple tests for phosphate," for the annual phosphate report.

Chase Palmer has been occupied largely with analyses of rocks, minerals, and natural waters. He has investigated the reactions between galena and iron arsenides and solutions of soluble silver salts, as a contribution to the study of the enrichment of silver ores, referred to on page 71. He has also begun experimental studies of the reactions that take place between water, petroleum, and adjacent mineral substances. The purpose of this investigation, which is supplementary to the geologic study mentioned on page 54, is to determine the cause of the peculiar composition of the waters in oil fields and of the chemical variations in the petroleum itself.

The investigations made in the physical laboratory are directed to the twofold object of ascertaining the possibilities of conducting researches along certain lines suggested by the geologists in the prosecution of their work and of providing for systematic research in a given field when the preliminary investigations show that the results expected will justify the work. The investigations outlined for the laboratory relate to the diffusion of solids, the construction of mathematical tables, measurements of temperature of deep wells, and determinations of porosity of gas and oil sands. The first two of these investigations are now permanent, but the last two have not yet passed through the preliminary stages.

Preliminary determinations of the porosity of gas and oil sands by A. F. Melcher indicate an increased degree of accuracy in the determinations. This work is being continued, with the expectation that the results will justify an extended study of porosity and related problems dependent on size and distribution of sand grains.

A report on measurements of earth temperatures and temperature in deep wells, by C. E. Van Orstrand and A. F. Melcher, is withheld from publication pending further observations in the field. Preliminary observations leave not much doubt in regard to the efficiency of the electric method, but further tests must be made in the field before the task of making a geothermal survey can be included in the systematic work of the laboratory.

Computations on mathematical tables have been made by A. T. Harris when he was not engaged in routine experimental work. Explanatory text to accompany the tables, consisting in part of a mathematical discussion of geophysical problems dependent upon diffusion of heat and substances in the crust of the earth, has been prepared by Mr. Van Orstrand.

Experiments on the diffusion of gold and silver into lead and tin in the solid state were made by Mr. Van Orstrand and Mr. Melcher in cooperation with Dr. F. P. Dewey, of the Treasury Department. A preliminary report on the diffusion of gold into lead was published as Professional Paper 95–G. A pressure pump has been added to the laboratory equipment for the prosecution of these and other experiments.

In addition to his administrative work as chief of the division, G. F. Becker has been occupied mainly in studies of capillarity and heat conduction from the geologist's point of view, but other subjects have claimed a part of his time. In November he read before the National Academy of Sciences a paper entitled "A possible origin for some spiral nebulae." This investigation bears on the origin of the earth, and the gist of it is that nebulae of the type discussed are vast diagrams illustrating Kepler's third law. In November Mr. Becker was also made a member of a committee of the National Academy of Sciences, appointed at the request of the President of the United States, to report on the slides in the Panama Canal, which Mr. Becker had studied in 1913, before water was admitted. As a result of this field work he was able to formulate a theory of the slides, which will doubtless appear in the final report of the committee, but as that report is not likely to be published for some time he has prepared his discussion for publication by the Survey as Professional Paper 98–N, "Mechanics of the Panama Canal slides." In this paper it is shown that the mechanics of the slides are reducible to identity with a soluble problem in capillarity, and that there is a sharp limit to the distance to which slides can extend. Mr. Becker has also printed in Science a short note of the history of the concept now known as energy. Contrary to current opinions, it was familiar to mathematicians of the first half of the eighteenth century.

With A. L. Day, Director of the Geophysical Laboratory, Mr. Becker also completed for publication a paper on the linear force of growing crystals. This is an experimental and theoretical refutation of attacks by certain foreign scientists on the deductions drawn from the results of an investigation made by the same authors some 10 years ago, when they pointed out the geologic importance of this force. In this country this linear force is now recognized as explaining the partial failure of many dams and as indicating how such failure may be avoided. The geologists of the State of Virginia also find it useful in explaining the phenomena of ore deposits. The new paper is in the hands of the printer.

In consultation and cooperation with Prof. P. W. Bridgman, of Harvard University, Mr. Becker has furnished some hollow cylinders of rock-forming minerals for use in pressure tests. The series is now nearly complete. Prof. Bridgman expects to compile and discuss the extremely interesting results this summer.

A number of analyses of phosphate rock and other miscellaneous analyses were made by W. C. Wheeler, whose work in conjunction with Mr. Clarke has already been mentioned. In February Mr. Wheeler resigned from the Survey and accepted an appointment in the Patent Office.

DIVISION OF MINERAL RESOURCES.

The Survey has continued its policy of making the annual report "Mineral Resources of the United States" more than a statistical compilation by recording and interpreting industrial progress and by treating in full the sources from which the mineral products of the country are obtained. This report is an annual inventory of the Nation's mineral resources.

During the last 13 years the separate chapters have been prepared in large part by geologists of the Survey who have specialized in the subjects treated by them, with a view to carrying out the provision of the organic act of the Survey which directs the examination of the mineral resources and products of the national domain.

Cooperation between the Geological Survey and the State surveys in collecting most of the mineral statistics continued in force in the preparation of the report for 1915. The 14 States that cooperated were Alabama, Florida, Illinois, Iowa, Maryland, Michigan, Minnesota, Missouri, New Jersey, North Carolina, Oregon, Virginia, Washington, and Wisconsin. The plan of cooperation has been modified somewhat for 1915, and results have been expedited. By cooperation duplication of a considerable amount of work is obviated, and so far as it is applied the producers are saved the annoyance of preparing two sets of statistical returns.

During the fiscal year the work of the division consisted in large part in the preparation of the reports on the mineral production of the United States in 1914 and 1915. The report for 1914 was published in two parts, as usual. On June 30, 1916, the manuscripts of 25 chapters for the report for 1915 had been completed and transmitted to the printer. On June 30, 1915, the manuscripts of 20 chapters for the report for 1914 had been completed and transmitted to the printer.

The conditions mentioned in the last administrative report in regard to the public interest in our mineral resources aroused by the European war continued to exist. In fact, the prolongation of the war has materially increased that interest, and in consequence a chapter for Mineral Resources of the United States, 1915, entitled "The public interest in mineral resources," was prepared by the Director of the Survey and issued December 31, 1915. A greatly increased number of inquiries for information concerning domestic supplies of minerals have been received by the division during the year, and the answers to the inquiries have involved an increased amount of research by the geologists and others. The number of recorded letters referred to the division for reply increased from 4,034 in 1915 to 6,434 in 1916, an increase of 59 per cent. The Geological Survey is becoming more and more a repository of information concerning the mineral resources of the country, much of which it furnishes through correspondence, giving detailed information which can not be covered by publications, such as the location of deposits of minerals, both those that are developed and those that are undeveloped, and names of those who can supply the different minerals.

Preliminary estimates of the output of antimony, arsenic, benzol, cement, coal, copper, gold and silver, iron ores, lead, manganese, petroleum, quicksilver, radium ores, sulphuric acid, titanium, tungsten ores, uranium ores, vanadium ores, metals in the Western States, and zinc in 1915, with reviews of the conditions that prevailed during the year, were issued in the form of special press bulletins during the later part of December, 1915, and in January, 1916. Advance statements giving the final figures covering the production of copper, lead, and zinc in 1915 have also been published.

For the first time in 1915 specialists of the division compiled midyear reviews on most of the principal mineral industries, indicating the trend and volume of changes during the first six months of the year, and these were given to the press of the country about July 1 and widely published. In addition members of this division prepared for the use of the Secretary of the Interior a summary of the mineral resources which was published in his annual report and was also widely republished. Several members of the division also devoted considerable time to the preparation of papers for the Pan American Scientific Congress held in Washington in December and January.

The number of members of the Survey (geologists, statisticians, and clerks) in Washington who devote their entire time to the work of the division of mineral resources is 32; and 8 are stationed in the offices of the division at Salt Lake City, Denver, and San Francisco. In addition to these, 22 members, chiefly geologists, who give part of their time to other divisions of the Survey, are also specialists in the work of the division of mineral resources, making a total of 62 persons engaged in the work.

During the year 210,042 pieces of first-class mail matter, comprising chiefly inquiries for information needed for the reports but also, in increasing quantity, replies to inquiries made to the Survey for information, were sent out by the division, an increase of 9 per cent over 1915, and 72,691 pieces were received, an increase of 11 per cent over 1915.

H. D. McCaskey became geologist in charge of the division at the beginning of the fiscal year, on the retirement of E. W. Parker. Mr. McCaskey also continued in charge of the metals section and has general supervision of the offices of the division in the Western States. E. F. Burchard, a geologist of much experience in economic work and a large contributor to Mineral Resources, has been placed in charge of the nonmetals section of the division. D. B. Sterrett, geologist, who for a number of years has had charge of the preparation of reports on gems and precious stones, mica, monazite, and zircon, was at his own request relieved of this work during the year. W. T. Schaller, who has made a special study of gems and rare minerals, has been assigned to the work of the preparation of reports on these subjects. Mr. Schaller has been referred to as the foremost mineralogist of the country and is therefore particularly well fitted for his new work.

The reports on the several mineral products were in charge of the following persons:

Authors of chapters in Mineral Resources.

Author.	Subject.
E. S. Bastin	Graphite.
A. H. Brooks	Gold, silver, and copper in Alaska.
E. F. Burchard	Cement; fluorspar and cryolite; iron ore, pig iron, and steel.
B. S. Butler	Copper (general report); copper and silver in Michigan (mines report).
C. A. Davis (of the Bureau of Mines).	Peat (1914).
J. S. Diller	Asbestos; chromic iron ore; talc and soapstone.
R. B. Dole	Mineral waters.
J. P. Dunlop	Silver, copper, lead, and zinc in the Central States, except Michigan (mines report); secondary metals; metals and ores (summary report).
H. S. Gale	Borax; magnesite (with C. G. Yale); nitrates.
C. N. Gerry	Gold, silver, copper, lead, and zinc in Idaho and Washington (mines report).
V. C. Heikes	Gold, silver, copper, lead, and zinc in Arizona, Montana, Nevada, and Utah (mines report).
C. W. Henderson	Gold, silver, copper, lead, and zinc in Colorado, New Mexico, South Dakota, Texas, and Wyoming (mines report).
F. L. Hess	Antimony, arsenic, bismuth, cobalt, molybdenum, nickel, selenium, tantalum, tungsten, titanium, vanadium, uranium, tin.
D. F. Hewett	Manganese and manganiferous ores.
J. M. Hill	Barytes and strontium; mineral paints; platinum and allied metals; gold, silver, copper, lead, and zinc in the Eastern States (mines report).
F. J. Katz	Abrasives; feldspar; silica (quartz).
C. E. Lesher	Coal; fuel briquetting; coke.
G. F. Loughlin	Building stone; lime; slate.
H. D. McCaskey	Gold and silver (general report); mineral products of the United States (summary report); quicksilver.
Jefferson Middleton	Clay, clay-working industries; fuller's earth; sand-lime brick.
J. D. Northrop	Petroleum; asphalt and bituminous rock; natural gas.
W. C. Phalen	Bauxite and aluminum; phosphate rock; potash salts; salt and bromine; sodium salts; sulphur and pyrite.
C. E. Siebenthal	Lead; zinc and cadmium (general reports).
W. T. Schaller	Gems and precious stones; mica.
R. W. Stone	Gypsum; sand and gravel.
C. G. Yale	Borax; magnesite (with H. S. Gale); gold, silver, copper, lead, and zinc in California and Oregon (mines report).

The offices of the division at Denver, Salt Lake City, and San Francisco are under direct charge of C. W. Henderson, V. C. Heikes, and C. G. Yale, respectively, who prepare the mine reports on gold, silver, copper, lead, and zinc in the Western States. They also act in cooperation with other members of the Survey where necessary, both in the field and in the office, and by keeping in close touch with the mining regions of the West they procure and disseminate much valuable information not readily obtained otherwise. These offices are therefore general Survey headquarters and bureaus of information in their respective regions. The Denver office, at 409 New Post Office Building, prepares the metal-mine reports for South Dakota, Wyoming, Colorado, and New Mexico; the Salt Lake City office, at 312 Post Office Building, covers in the same way the States of Montana, Idaho, Washington, Utah, Nevada, and Arizona; and the San

Francisco office, at 305 Customhouse, is the headquarters for California and Oregon.

TOPOGRAPHIC BRANCH.

ORGANIZATION.

The organization of the topographic branch is as follows:

Acting chief geographer, W. H. Herron.
Atlantic division, Frank Sutton, geographer, in charge.
Central division, G. S. Smith, topographic engineer, in charge.
Rocky Mountain division, C. H. Birdseye, topographic engineer, in charge.
Northwestern division, T. G. Gerdine, geographer, in charge.
Pacific division, G. R. Davis, geographer, in charge.
Inspectors of topography, J. H. Renshawe, geographer; W. M. Beaman and A. M. Walker, topographic engineers.

PERSONNEL.

The technical corps of the topographic branch was increased during the year by the reinstatement of 2 assistant topographers and was reduced 14 by death, transfers, and resignations. With these changes the corps now includes 1 acting chief geographer, 47 geographers and topographic engineers, 17 topographers, 40 assistant topographers, 35 junior topographers, and 7 draftsmen—a total of 147. In addition, 36 technical field assistants were employed during the whole or a part of the field season. One topographic engineer, 1 topographer, and 6 junior topographers are on furlough. The clerical force comprises 11 clerks of various grades.

PUBLICATIONS.

The published work of the topographic branch for the fiscal year consists of 153 maps and six bulletins, giving results of spirit leveling in Arizona, Colorado, Louisiana, Maine, Missouri, and West Virginia. Brief summaries of the book publications (Bulletins 565, 568, 573, 632, 633, and 634) are given on pages 21 and 30. Manuscript for results of triangulation and primary traverse in the United States, 1913–1915 (Bulletin 644), in 18 parts, was brought up to date and two parts were published. Manuscript for a new edition of "Geographic tables and formulas" (Bulletin 650) and for all results of leveling in Ohio (Bulletin 651) was transmitted for publication.

ALLOTMENTS.

The total appropriations for topographic surveys for the fiscal year 1916 were:

Topographic surveys	$350,000
Surveying national forests	75,000
Statutory salaries	9,200
	434,200

Allotments of these appropriations were made as follows:

Allotments from funds appropriated for topographic work, fiscal year 1916.

	Topographic surveys and statutory salaries.	Surveying national forests.
General administration	$22,896	$4,500
Clerical assistance and supervision	17,149	3,271
Map editing	3,735	765
Purchase and repair of instruments, stationery, etc	12,242	2,508
Millionth-scale map	20,000	....
Work by land-classification board	9,000	2,500
Field work:		
Atlantic division	67,950	....
Central division	59,488	....
Rocky Mountain division	62,135	21,206
Northwestern division	33,663	26,250
Pacific division	50,942	14,000
	359,200	75,000

COOPERATION.

Cooperation has been maintained in 17 States, which contributed the following amounts:

California	$14,000.00	New York	$10,000.00
Illinois	9,000.00	Ohio	23,900.00
Illinois drainage	3,000.00	Oregon	4,000.00
Iowa	1,750.00	Texas	35,000.00
Kentucky	10,000.00	Vermont	2,500.00
Maine	5,000.00	Virginia	4,500.00
Michigan	15,000.00	Washington	11,500.00
Minnesota	4,250.00	West Virginia	7,639.39
Missouri	4,000.00		
Nebraska	1,750.00		166,789.39

GENERAL OFFICE WORK.

Progress maps were kept up to date and new ones were compiled when necessary, the new 1:500,000 State maps being used so far as available. Results of computations for vertical and horizontal control work were copied and catalogued.

The computations of control data were made principally by D. H. Baldwin, T. M. Bannon, D. S. Birkett, G. T. Hawkins, Oscar Jones, C. B. Kendall, L. S. Leopold, F. J. McMaugh, E. L. McNair, J. B. Metcalfe, jr., C. L. Nelson, H. S. Senseney, Frank Tweedy, and J. H. Wilson, under the immediate supervision of E. M. Douglas, geographer. Computing by L. F. Biggs and C. F. Urquhart was done in the Sacramento office. S. S. Gannett, geographer, was engaged in preparing manuscript and compiling data for the bulletins submitted for publication, in miscellaneous computations, and in furnishing triangulation and leveling data for field and office use.

J. H. Renshawe was engaged during the year in preparing reli maps of the United States and of the Mesa Verde National Pa and in revising the relief map of Alaska for the division of Alask mineral resources.

In the preparation of the special topographic maps to be used the transcontinental guidebooks the available Survey atlas she were used, and for areas for which such sheets were not availa the data were filled in on field sheets on the scale of 5 miles to inch. The different railroads assisted in every way possible, supp ing all available profile and alignment data and rendering ot valuable assistance. The maps are to be published on a scale 1: 500,000, or about 8 miles to the inch, and cover the Denver & Grande Railroad from Denver, Colo., to Salt Lake City, Utah, the Southern Pacific Railroad from El Paso, Tex., to San Francis Cal., by way of Los Angeles and San Joaquin Valley. The m for the Denver & Rio Grande Route were completed; those for other route have just been begun.

SUMMARY OF RESULTS.

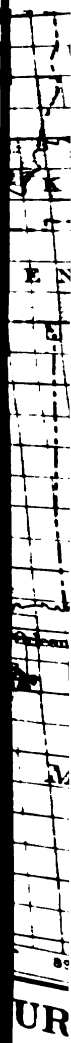
The condition of topographic surveys to June 30, 1916, dis guished as to scale, etc., is shown on Plate II.

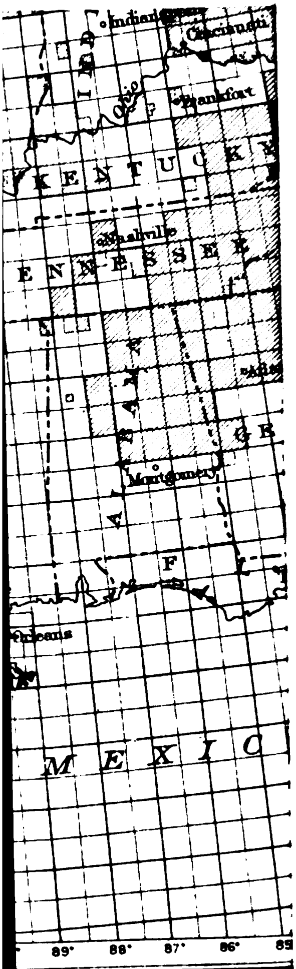
As shown in the following tables, the total new area mapped 19,230 square miles, making the total area surveyed to date in United States 1,237,520 square miles, or 40.9 per cent of the en country. In addition, 3,486 square miles of resurvey was comple making the total area of surveys during the year 22,716 square mi

In connection with these surveys, 5,462 linear miles of prim levels were run, making 259,821 miles of primary and precise le run since the authorization of this work by Congress in 1896. the course of this work 1,321 permanent bench marks were es lished. In addition, 604 linear miles of river surveys were run.

Triangulation stations to the number of 244 were occupied, 200 were permanently marked. Primary traverse lines aggrega 2,905 miles were run, in connection with which 331 permanent m were set. In the course of this work areas aggregating 23,384 sq miles were covered by primary control.

The area covered by topographic surveys in Alaska during fiscal year, as reported in detail on page 91, was 10,412 square mi





URVEYS PRIOR

Present condition of topographic surveys of the United States and new area surveyed July 1, 1915, to June 30, 1916.

	New area mapped July 1, 1915, to June 30, 1916.	Total area mapped to June 30, 1916.	Percentage of total area of State mapped to June 30, 1916.
	Sq. miles.	*Sq. miles.*	
Alabama		19,192	37
Arizona	546	69,542	61
Arkansas	114	21,494	40
California	2,262	116,970	74
Colorado	1,667	50,450	49
Connecticut		4,965	100
Delaware		1,202	51
District of Columbia		70	100
Florida		2,339	4
Georgia	250	17,587	29
Idaho	1,069	27,254	32
Illinois	693	15,244	27
Indiana	168	3,609	10
Iowa	113	11,765	21
Kansas		64,159	78
Kentucky	41	18,014	44
Louisiana	47	8,366	17
Maine	404	9,765	29
Maryland		12,327	100
Massachusetts		8,266	100
Michigan	1,077	7,095	12
Minnesota	424	6,965	8
Mississippi		2,126	4
Missouri	15	36,725	53
Montana	626	57,789	39
Nebraska	228	26,752	36
Nevada		51,115	46
New Hampshire		3,380	36
New Jersey		8,224	100
New Mexico	1,333	38,580	31
New York	806	44,359	90
North Carolina		18,390	35
North Dakota	98	9,814	14
Ohio	1,022	41,040	100
Oklahoma		39,851	57
Oregon	997	24,403	25
Pennsylvania		24,908	55
Rhode Island		1,248	100
South Carolina		5,640	18
South Dakota	299	18,893	24
Tennessee	130	21,283	50
Texas	1,518	69,300	26
Utah		68,797	81
Vermont	216	4,406	46
Virginia		29,980	70
Washington	1,713	27,746	40
West Virginia		24,170	100
Wisconsin	399	12,602	22
Wyoming	955	29,359	30
Total, United States	19,230	1,237,520	40.9
Hawaii		1,393	22

ATLANTIC DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Alabama, Georgia, Louisiana, Maine, New Hampshire, New York, Pennsylvania, Tennessee, Vermont, Virginia, and West Virginia and in a small area in Arkansas. This work comprised the completion of the survey of 10 quadrangles and of the resurvey of 4 quadrangles, in addition to which 2 quadrangles were partly surveyed and 10 were partly resurveyed. The total new area mapped was 1,967 square miles, for publication on the scale of 1:62,500, and the area resurveyed was 1,164 square miles, for publication on the same scale. The map of one quadrangle was partly revised, the area covered by this revision being 21 square miles. In connection with this work, 796 miles of primary levels were run and 199 permanent bench marks were established.

Primary triangulation and primary traverse were carried on by six parties in Georgia, Maine, New York, Arkansas, Vermont, and West Virginia. The total area covered by this work was about 1,525 square miles. The primary traverse covered 900 square miles, 300 miles being run and 30 permanent marks set. In the triangulation 29 stations were occupied and 18 were permanently marked. This work made control available in 15 quadrangles.

Topographic surveys in Atlantic division from July 1, 1915, to June 30, 1916.

State.	Contour interval.	For publication on scale of 1:62,500.		Total area surveyed.	Primary levels.		Primary traverse.		Triangulation.	
		New.	Resurvey.		Distance run.	Bench marks.	Distance run.	Permanent marks.	Stations occupied.	Stations marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Alabama	20		151	151						
Georgia	20	250		250	90	29	211	17		
Louisiana	5, 10	47		47						
Maine	20	404		404	67	16			8	
New Hampshire	20		59	59	32	9				
New York	20	806		806	98	31	87	13		
Pennsylvania					86	10				
Tennessee	5, 10	130		130	40	9				
Vermont	20	216		216	66	22			3	5
Virginia	50		355	355	34	9				
West Virginia	50		599	599	245	55			18	13
Arkansas	5, 10	114		114	38	9	2			
		1,967	1,164	3,131	796	199	300	30	29	18

Alabama.—The resurvey of the Weogufka quadrangle, in Coosa, Shelby, and Talladega counties, was completed by Duncan Hannegan and W. H. S. Morey, the area mapped being 151 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

Arkansas.—(See Tennessee and Arkansas, p. 112.)

District of Columbia, Maryland, and Virginia.—During the year the revision of the culture on the map of Washington and vicinity was completed.

Georgia.—The mapping of the Black Lake quadrangle, in Baldwin, Hancock, Washington, and Wilkinson counties, was begun by J. I. Gayetty, C. W. Arnold, K. E. Schlachter, and E. W. Bowler, the area mapped being 250 square miles, for publication on the scale of 1:48,000, with a contour interval of 20 feet. For the control of this area Mr. Arnold, Mr. Schlachter, and Kostka Mudd ran 90 miles of primary levels and established 29 permanent bench marks, and for the control of this area and of the Griswoldville, Milledgeville, Sandersville, Macon, Meriweather, and Jefferson quadrangles, in Baldwin, Bibb, Jones, Twiggs, Wilkinson, Hancock, Putnam, Pulaski, Washington, Monroe, and Laurens counties, C. B. Kendall, Mr. Arnold, Mr. Schlachter, Mr. Mudd, and Mr. Bowler ran 211 miles of primary traverse and set 17 permanent marks.

Louisiana and Mississippi.—The mapping of the Natchez quadrangle, in Concordia County, La., and Adams and Jefferson counties, Miss., was begun by E. I. Ireland, W. H. S. Morey, T. F. Slaughter, and F. W. Crisp, the area mapped being 47 square miles, for publication on the scale of 1:62,500, with contour intervals of 5 and 10 feet. This work was in Louisiana.

Maine.—For the continuation of cooperative topographic surveys the Public Utilities Commission allotted $5,000 and the United States Geological Survey allotted an equal amount. The survey of the Belfast and Passadumkeag quadrangles, in Knox, Waldo, and Penobscot counties, was completed and that of the Winn quadrangle, in Penobscot County, was begun by W. H. Griffin, J. I. Gayetty, James McCormick, J. B. Metcalfe, jr., and C. S. Wells, the total area mapped being 404 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Passadumkeag quadrangle Mr. Wells ran 67 miles of primary levels and established 16 permanent bench marks, and for the control of the Seboeis quadrangle, in Penobscot County, Oscar Jones occupied 8 triangulation stations.

Maine and New Hampshire.—The resurvey of the Dover and York quadrangles, in York County, Maine, and Rockingham and Strafford counties, N. H., was begun by Hersey Munroe and J. H. Wheat, the area mapped being 59 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Dover quadrangle C. H. Stewart ran 32 miles of primary levels and established 9 permanent bench marks. All this work was in New Hampshire.

New York.—The mapping of the Hornell, Russell, Moira, Oneonta, and Unadilla quadrangles, in Allegany, Livingston, Steuben, St. Lawrence, Franklin, Delaware, Otsego, and Chenango counties, was completed and that of the Oswegatchie, Andes, and Cranberry Lake quadrangles, in Herkimer, Lewis, Delaware, Sullivan, Ulster, Hamilton, and St. Lawrence counties, was begun by G. S. Smith, Hersey Munroe, Robert Muldrow, W. J. Lloyd, A. P. Meade, T. F. Slaughter, J. M. Whitman, J. I. Gayetty, J. B. Metcalfe, jr., C. S. Wells, K. E. Schlachter, C. H. Davey, and E. W. Bowler, the total area mapped being 806 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

For the control of the Cranberry Lake and Andes quadrangles C. B. Kendall and F. J. McMaugh ran 87 miles of primary traverse and set 13 permanent marks, and Mr. Schlachter and F. L. Shalibo ran 98 miles of primary levels and established 31 permanent bench marks.

Pennsylvania.—For the control of the Newville quadrangle, in Cumberland, Adams, Franklin, and Perry counties, De Witt McLaughlin ran 86 miles of primary levels and established 10 permanent bench marks. The revision of a part of the map of the Houtzdale quadrangle, in Clearfield and Center counties, was completed by J. I. Gayetty, the area covered being 21 square miles.

Tennessee and Arkansas.—The mapping of the Memphis quadrangle, in Shelby County, Tenn., and Crittenden County, Ark., was begun by E. I. Ireland, W. H. S. Morey, T. F. Slaughter, F. W. Crisp, and Kostka Mudd, the area mapped being 244 square miles. for publication on the scale of 1:62,500, with contour intervals of 5 and 10 feet. Of this area 114 square miles is in Arkansas. For the control of this area H. S. Senseney ran 78 miles of primary levels and established 18 permanent marks, of which 38 miles and 9 marks were in Arkansas, and Mr. Crisp and Mr. Mudd ran 2 miles of primary traverse, also in Arkansas.

Vermont.—For the continuation of cooperative topographic surveys the governor of Vermont allotted $2,500 and the United States Geological Survey allotted an equal amount. The survey of the Rochester quadrangle, in Addison, Orange, Rutland, and Windsor counties, was completed by Hersey Munroe and K. F. Maxcy, the area mapped being 216 square miles, for publication on the scale of 1:62,500, with a contour of 20 feet. For the control of this area K. E. Schlachter ran 66 miles of primary levels and established 22 permanent bench marks, and D. H. Baldwin occupied 3 triangulation stations and marked 5.

Virginia.—For the continuation of cooperative topographic surveys the State geologist allotted $4,500 and the United States Geological Survey allotted an equal amount. The resurvey of the Virginia portion of the Nolansburg quadrangle, in Lee County, and that of the coal areas in the Cleveland, Richlands, and Burkes Garden quadrangles and in the Virginia portion of the Pounding Mill quadrangle, in Buchanan, Russell, and Tazewell counties, was completed and that of the coal area in the Coeburn quadrangle, in Russell and Wise counties, was begun by Fred McLaughlin, C. W. Arnold, and Kostka Mudd, the area mapped being 355 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of the Pounding Mill and Nolansburg quadrangles Mr. Arnold and S. R. Archer ran 34 miles of primary levels and established 9 permanent bench marks.

West Virginia.—For the continuation of cooperative topographic surveys the State geologist expended $7,639.39 and the United States Geological Survey expended $2,407.39. A resurvey of the Cowen and Webster Springs quadrangles and of the portions of the Mingo, Lobelia, and Richwood quadrangles lying in Nicholas and Webster counties was completed by E. I. Ireland, W. H. S. Morey, F. W. Farnsworth, and Klett McKinley, the total area mapped being 599 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. This work completed the mapping of Nicholas and Webster counties on the scale of 1:62,500. In connection with this work H. S. Senseney ran 147 miles of primary levels and established 31 permanent bench marks. For the control of the West Virginia portions of the Davis, Elk Garden, and Keyser quadrangles, in Tucker and Mineral counties, J. B. Metcalfe, jr., occupied 18 triangulation stations and marked 13, and for the control of the Piedmont quadrangle, in Tucker and Mineral counties, K. F. Maxcy ran 98 miles of primary levels and established 24 permanent bench marks.

OFFICE WORK.

The drafting of the following sheets was completed: Gantts Quarry, Ala; Interlachen, Fla.; Belfast and Passadumkeag, Maine; Vicksburg, Miss.-La.; Hornell, Malone, Moira, Oneonta, Russell, and Unadilla, N. Y.; Houtzdale, Pa. (revision); Rochester, Vt.; Cowen and Webster Springs, W. Va.; and Washington and vicinity, D. C.-Md.-Va.

Progress in the drafting of additional sheets was made as follows: Cleveland, Va., 17 per cent; Pounding Mill, Va., 33 per cent; Richlands, Va., 78 per cent; Lobelia, W. Va., 4 per cent; Mingo, W. Va., 9 per cent; Richwood, W. Va., 43 per cent.

Primary-level circuits were adjusted for the following quadrangles: Weogufka, Ala.; Passadumkeag, Maine; Natchez, Miss.; Gastonia, N. C.; Andes and Oneonta, N. Y.; Memphis, Tenn.; Pounding Mill, Va.; Rochester, Vt.; and Clay, Cowen, Fayetteville, Gassaway, Richwood, Summersville, Sutton, Webster Springs, and Winona, W. Va.

Geographic positions were computed for the following quadrangles: Black Lake, Ga.; Memphis, Tenn.; Rochester, Vt.; and Cowen, Davis, Elk Garden, Keyser, Richwood, and Webster Springs, W. Va.

CENTRAL DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. The work comprised the completion of the survey of 11 quadrangles and the resurvey of 6 quadrangles, in addition to which 29 quadrangles were partly surveyed and 3 quadrangles and 1 special area were partly resurveyed. The total new area mapped was 3,852 square miles, 3,798 square miles for publication on the scale of 1:62,500 and 54 square miles for publication on the scale of 1:24,000; and the area resurveyed was 1,524 square miles, 1,515 square miles for publication on the scale of 1:62,500 and 9 square miles for publication on the scale of 1:24,000. In connection with this work 2,527 miles of primary levels were run and 589 permanent bench marks were established.

Primary triangulation and primary traverse were carried on by six parties in Illinois, Indiana, Kansas, Kentucky, Michigan, Minnesota, and Missouri. The total area covered by this work was about 6,350 square miles. The primary traverse covered 5,250 square miles, 1,924 miles being run and 164 permanent marks set. In the triangulation 13 stations were occupied and 13 marked. The result of this work was to make control available in 58 quadrangles.

Topographic surveys in central division from July 1, 1915, to June 30, 1916.

State.	Contour interval.	For publication on scale of—				Total area surveyed.	Primary levels.		Primary traverse.		Triangulation stations.	
		1:62,500		1:24,000			Distance run.	Bench marks.	Distance run.	Permanent marks.	Occupied.	Marked.
		New.	Resurvey.	New.	Resurvey.							
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Illinois	5,20	639	421	54	......	1,114	417	116	321	28	......	......
Indiana	20	168	......	......	......	168	32	7	60	4	......	......
Iowa	20	113	......	......	......	113	......	......	......	......	......	......
Kentucky	20,50	41	857	......	......	898	412	98	24	2	13	1
Michigan	5	1,077	......	......	......	1,077	1,080	237	968	81	......	......
Minnesota	10	324	......	......	......	324	244	66	310	28	......	......
Missouri	20	15	237	......	9	261	224	37	163	14	......	......
Ohio	10,20	1,022	......	......	......	1,022	......	......	......	......	......	......
Wisconsin	20	399	......	......	......	399	118	28	......	......	......	......
Kansas	......	......	......	......	......	......	......	......	78	7	......	......
	......	3,798	1,515	54	9	5,376	2,527	589	1,924	164	13	1

Illinois.—The governor of Illinois allotted $9,000 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. The governor also made an additional allotment of $3,000 for a survey of the Pecatonica drainage basin, which was met by an allotment of $1,500 by the Federal Survey. The survey of the Illinois portions of the Brownfield and Altenberg quadrangles, in Jackson, Johnson, Massac, and Pope counties, was completed and that of the Vienna and Good Hope quadrangles and of the Illinois portion of the Campbell Hill quadrangle, in Jackson, Johnson, McDonough, Massac, Perry, Pulaski, Randolph, and Warren counties, was begun by C. W. Goodlove, Gilbert Young, J. A. Duck, F. W. Hughes, J. M. Rawls, R. M. Herrington, M. A. Roudabush, and H. E. Burney, the total area mapped being 639 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The resurvey of the Morris quadrangle, in Grundy and Kendal counties, was completed and that of the Wilmington quadrangle, in Will and Kankakee counties, was begun by R. L. Harrison, the area mapped being 421 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Campbell Hill, Wilmington, and Vienna quadrangles R. G. Clinite, J. M. Perkins, and Mr. Rawls ran 281 miles of primary levels and established 80 permanent bench marks, and for the control of these areas and of the Peotone, Essex, Joliet, Dongola, Joppa, and Marion quadrangles and of the Illinois portions of the Jonesboro and Thebes quadrangles, in Kankakee, Cook, Will, Alexander, Grundy, Livingston, Massac, Pulaski, Dupage, Johnson, Union, and Williamson counties, J. H. Wilson ran 209 miles of primary traverse and set 19 permanent marks.

The survey of the Pecatonica drainage basin, covering parts of the Freeport, Pecatonica, and Rockford quadrangles, in Stephenson and Winnebago counties, was completed by L. L. Lee, R. M. Herrington, and W. S. Gehres, the area mapped being 54 square miles, for publication on the scale of 1:24,000, with a contour interval of 5 feet. For the control of this area Mr. Perkins and Mr. Gehres ran 136 miles of primary levels and established 36 permanent bench marks and Mr. Wilson ran 112 miles of primary traverse and set 9 permanent marks.

Indiana.—The mapping of the Indiana portion of the Lynn quadrangle, in Randolph and Wayne counties, was begun by W. L. Miller and L. B. Glasgow, the area mapped being 168 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area Mr. Glasgow ran 32 miles of primary levels and established 7 permanent bench marks, and for the control of this area and the Farmland quadrangle and of the Indiana portions of the Fort Recovery and New Paris quadrangles, in Delaware, Henry, Jay, Randolph, and Wayne counties, J. H. Wilson ran 60 miles of primary traverse and set 4 permanent marks.

Iowa.—The State geologist allotted $1,750 for the continuation of cooperative topographic surveys in Iowa, and the United States Geological Survey allotted an equal amount. The survey of the Chariton quadrangle, in Lucas, Marion, and Warren counties, was continued by W. L. Miller, the area mapped being 113 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

Kansas.—For the control of the Joplin district J. H. Wilson ran 78 miles of primary traverse and set 7 permanent marks in the Columbus quadrangle, in Cherokee county.

Kentucky.—The Kentucky Geological Survey allotted $10,000 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. The survey of the Kentucky portion of the Golconda quadrangle, in Crittenden and Livingston counties, was begun by C. W. Goodlove and R. F. Wilcoxon, the area mapped being 41 square miles, for publication on the scale of 1:48,000, with a contour interval of 20 feet. The resurvey of the Goodloe and Paintsville quadrangles and of the Kentucky portions of the Regina and Nolansburg quadrangles, in Breathitt, Floyd, Harlan, Johnson, Lawrence, Letcher, Magoffin, Morgan, Perry, and Pike counties, was completed and that of the Baxter quadrangle, in Harlan and Leslie counties, was begun by J. R. Eakin, C. S. Wells, Howard Clark, W. A. Reiter, F. W. Farnsworth, W. S. Gehres, G. W. Lucas, S. A. Judson, and E. J. Essick, the area mapped being 857 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of these areas and of the Hyden and Fords Ferry quadrangles, in Harlan, Leslie, Perry, Crittenden, Livingston, and Caldwell counties, Mr. Judson, S. R. Archer, G. W. Lucas, and F. L. Whaley ran 412 miles of primary levels and established 98 permanent bench marks. For the control of the Kentucky portions of the Fords Ferry and Golconda quadrangles J. H. Wilson ran 24 miles of primary traverse and set 2 permanent marks, and for the control of the Hyden quadrangle and of the Corbin, Maynardsville, Pineville, Barbourville, and Log Mountain quadrangles, in Bell, Campbell, Claiborne, Granger, Jefferson, Clay, Knox, Laurel, Harlan, Leslie, Sevier, and Whitley counties, E. L. McNair occupied and marked 13 triangulation stations.

Michigan.—For the continuation of cooperative topographic surveys the State geologist allotted $15,000 and the United States Geological Survey allotted an equal amount. The survey of the Chesaning quadrangle, in Saginaw and Shiawassee counties, was completed and that of the Elsie, Perrinton, Bay City, Cedar Springs, Kalamazoo, Lowell, Saginaw, and Mount Pleasant quadrangles, in Clinton, Gratiot, Kent, Allegan, Barry, Kalamazoo, Bay, Ionia, Isabella, Shiawassee, and Saginaw counties, was begun by J. H. Jennings, C. L. Sadler, Robert Muldrow, A. T. Fowler, A. B. Searle, J. G. Staack, Fred Graff, jr., L. L. Lee, E. L. Hain, S. H. Birdseye, E. C. Burt, and H. E. Burney, the area mapped being 1,077 square miles, for publication on the scale of 1:62,500, with a contour interval of 5 feet. For the control of these areas and of the Carson City, Vestaburg, Fenwick, Ionia, Muir, Ithaca, and Merrill quadrangles, in Barry, Eaton, Gratiot, Montcalm, Clinton, Ionia, Isabella, Midland, and Saginaw counties, H. S. Senseney, E. C. Bibbee, and R. G. Clinite ran 1,080 miles of primary levels and established 237 permanent bench marks. For the control of the Cedar Springs, Kalamazoo, Carson City, Fenwick, Lowell, Ionia, Muir, Springport, Rives Junction, Maple City, Traverse City, Elk Rapids, Saginaw, Mount Pleasant, Vestaburg, and Bay City quadrangles, in Kent, Allegan, Barry, Kalamazoo, Clinton, Gratiot, Ionia, Montcalm, Bay, Eaton, Isabella, Saginaw, Jackson, Calhoun, Ingham, Leelanau, Benzie, Grand Traverse, Antrim, and Alkaska counties, Oscar Jones ran 968 miles of primary traverse and set 81 permanent marks.

Minnesota.—The State drainage engineer of Minnesota allotted $4,250 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. The survey of the Brainerd quadrangle, in Crow Wing County, was completed and that of the Tarn and Sylvan quadrangles, in Anoka, Isanti, Cass, Crow Wing, and Morrison counties, was begun by S. G. Lunde, F. B. Barrett, J. L. Lewis, and W. S. Gehres, the total area mapped being 284 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of the Tarn and Sylvan quadrangles and of the Cushing quadrangle, in Morrison and Todd counties, E. C. Bibbee and C. E. Mills ran 244 miles of primary levels and established 66 permanent bench marks. For the control of the Sylvan, Tarn, Lakenetta, Walbo, Elk River, Pine River, Belle Prairie, Swanville, Cushing, Motley, Lastrup, Little Falls, and Browerville quadrangles, in Cass, Crow Wing, Morrison, Anoka, Isanti, Chisago, Washington, Kanabec, Sherman, Wright, Todd, Benton, and Stearns counties, J. H. Wilson ran 310 miles of primary traverse and set 28 permanent marks. The mapping of the Minnesota portion of the Superior quadrangle was completed by L. B. Roberts, the area mapped being 40 square miles, for publication on the same scale as the Wisconsin portion. (See also p. 122.)

Missouri.—For the continuation of cooperative topographic surveys the State geologist allotted $4,000 and the United States Geological Survey allotted an equal amount. The resurvey of the Knobnoster quadrangle, in Johnson and Lafayette counties, was completed and that of the Halltown quadrangle and of the Spring City special area, in Christian, Greene, Lawrence, and Newton counties, was commenced by F. W. Hughes, J. M. Rawls, and F. L. Whaley, the area mapped being 246 square miles, 237 square miles for publication on the scale of 1:62,500, with a contour interval of 10 feet, and 9 square miles for publication on the scale of 1:24,000, with a contour interval of 10 feet. For the control of the Knobnoster and Halltown quadrangles and of the Stotts City and Sarcoxie quadrangles, in Jasper, Lawrence, and Newton counties, Mr. Rawls and Mr. Whaley ran 224 miles of primary levels and established 37 permanent bench marks, and for the control of the Halltown, Stotts City, and Sarcoxie quadrangles J. H. Wilson ran 124 miles of primary traverse and established 11 permanent marks.

The mapping of the Missouri portion of the Campbell Hill quadrangle, in Perry County, was commenced by Gilbert Young and M. A. Roudabush, the area mapped being 15 square miles, for publication on the same scale as the Illinois portion.

In addition to the cooperative work Mr. Wilson ran 39 miles of primary traverse and set 3 permanent marks for the control of the Joplin district, in Jasper and Newton counties.

Ohio.—For the completion of the cooperative topographic survey of Ohio the governor allotted $23,900 and the United States Geological Survey allotted $10,000. The survey of the Bainbridge, Piketon, Seaman, Peebles, Otway, and Kelleys Island quadrangles and of the Ohio portions of the Felicity, College Corner, Higginsport, Vanceburg, Garrison, Morningview, Maysville, and Springdale quadrangles, in Adams, Highland, Pike, Ross, Brown, Clermont, Butler, Preble, Scioto, and Ottawa counties, was completed by J. H. Jennings, C. W. Goodlove, A. B. Searle, W. L. Miller, Gilbert Young, R. L. Harrison, J. A. Duck, W. S. Gehres, H. E. Burney, E. C. Burt, M. A. Roudabush, G. W. Lucas, W. A. Reiter, and Howard Clark, the total area mapped being 1,022 square miles, for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet.

Wisconsin.—The State geologist of Wisconsin allotted $4,000 during the fiscal year 1915 for the beginning of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. As all the State funds were not expended, the work was continued during the last year. The survey of the Neshkoro and Ripon quadrangles and of the Wisconsin portion of the Superior quadrangle, in Fond du Lac, Green Lake, Marquette, Waushara, Winnebago, and Douglas counties, was completed by L. L. Lee, S. G. Lunde, L. B. Roberts, and R. M. Herrington, the total area mapped being 399 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Neshkoro and Ripon quadrangles J. M. Perkins ran 118 miles of primary levels and established 28 permanent bench marks. As the cooperative funds were not sufficient to complete this work, an additional allotment was made from Federal funds.

OFFICE WORK.

The drafting of the following sheets was completed: Morris and Pecatonica drainage basin, Ill.; Goodloe and Paintsville, Ky.; Regina, Ky.-Va.; Matewan, Naugatuck, and Williamson, Ky.-W. Va.; Chesaning, Mich.; Brainerd, Minn.; Eminence and Knobnoster, Mo.;

Bainbridge, Hillsboro, Otway, Piketon, Sardinia, and Seaman, Ohio; Neshkoro, Wis.; Superior, Wis.-Minn.

Progress in the drafting of additional sheets was made as follows: Altenberg, Ill., 9 per cent; Brownfield, Ill.-Ky., 98 per cent; Campbell Hill, Ill., 38 per cent; Chariton, Iowa, 90 per cent; Hurley, Ky.-Va., 87 per cent; Perrinton, Mich., 10 per cent; Tarn, Minn., 15 per cent; College Corner, Ohio-Ind., 25 per cent; Felicity, Ohio-Ky., 82 per cent; Fort Recovery, Ohio-Ind., 22 per cent; Garrison, Ohio-Ky., 36 per cent; Harrison, Ohio-Ind., 27 per cent; Higginsport, Ohio-Ky., 95 per cent; Lawrenceburg, Ohio-Ind.-Ky., 15 per cent; Lynn, Ohio-Ind., 23 per cent; Maysville, Ohio-Ky., 9 per cent; Morningview, Ohio-Ky., 5 per cent; New Paris, Ohio-Ind., 25 per cent; Peebles, Ohio, 45 per cent; Springdale, Ohio-Ky., 35 per cent; Vanceburg, Ohio-Ky., 41 per cent; Ripon, Wis., 27 per cent.

Primary-level circuits were adjusted for the following quadrangles: Memphis, Ark.; Campbell Hill, Freeport, Morris, Pecatonica, Rockford, Vienna, and Wilmington, Ill.; Baxter, Goodloe, Hurley, Hyden, Matewan, Naugatuck, Nolansburg, Paintsville, Regina, and Williamson, Ky.; Burt, Chesaning, Elsie, Ithaca, Kalamazoo, Merrill, and Perrinton, Mich.; Cushing, Sylvan, and Tarn, Minn.; Knobnoster, Mo.; Felicity, Morningview, Piketon, Roxabell, and Seaman, Ohio; and Neshkoro and Ripon, Wis.

Geographic positions were computed for the following quadrangles: Memphis, Ark.; Belvidere, Campbell Hill, Dongola, Essex, Joliet, Joppa, Marion, Oregon, Pecatonica, Peotone, Rockford, Vienna, and Wilmington, Ill.; Farmland, Fort Recovery, and New Paris, Ind.; Lynn, Ohio-Ind.; Fords Ferry, Goodloe, Golconda, and Paintsville, Ky.; Bay City, Burt, Carson City, Cedar Springs, Chesaning, Elk Rapids, Elsie, Empire, Fenwick, Ionia, Kalamazoo, Lowell, Maple City, Mount Pleasant, Muir, Perrinton, Rives Junction, Saginaw, Smyrna, Springport, Traverse City, and Vestaburg, Mich.; Belle Prairie, Browerville, Cushing, Lastrup, Little Falls, Motley, Pine River, Sylvan, and Tarn, Minn.; Halltown, Sarcoxie, Stotts City, and Joplin, Mo.; and Brodhead, Wis.

ROCKY MOUNTAIN DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Colorado, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming, with a small area extending into Minnesota. Montana was included in the northwestern division during the year, and therefore the results for the entire year are reported under that division (p. 126). The work comprised the completion of the survey of 19 quadrangles, in addition to which 36 quadrangles were partly surveyed. The total new area mapped was 6,198 square miles, 3,329 square miles for publication on the scale of 1:125,000, 1,323 square miles for publication on the scale of 1:62,500, and 1,546 square miles for publication on the scale of 1:31,680. In addition, the revision of the maps of 2 quadrangles was begun, the area covered being 8 square miles. In connection with this work, 1,280 miles of primary levels were run and 326 permanent bench marks were established. Profile surveys were made of parts of five rivers, the distance traversed being 230 linear miles, in connection with which 28 square miles were surveyed on the scale of 1:31,680.

Primary traverse and primary triangulation were carried on by eight parties in Colorado, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. The total area covered by this work was 4,979 square miles. The primary traverse covered 2,201 square miles, 681 miles being run and 137 permanent marks set. In the triangulation 36 stations were occupied and 16 marked. This work made control available in 43 quadrangles.

Topographic surveys in Rocky Mountain division from July 1, 1915, to June 30, 1916.

State.	Contour interval.	For publication on scale of—			Total area surveyed, new.	Primary levels.		Primary traverse.		Triangulation.	
		1:125,000	1:62,500	1:31,680		Distance run.	Bench marks.	Distance run.	Permanent marks	Stations occupied.	Stations marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Colorado	50, 100	1,531	136		1,667	84	22			24	8
Nebraska	20		228		228	45	12	54	17		
New Mexico	5, 25, 50, 100	1,065	240	28	1,333	119	31			8	5
North Dakota	10		98		98	33	9	15	3		
Oklahoma								162	23		
South Dakota	10		299		299	134	38	104	10		
Texas	1, 5			1,518	1,518	645	180	270	75		
Wyoming	50, 100	733	222		955	166	33			4	3
Minnesota	10		100		100	54	1	76	9		
		3,329	1,323	1,546	6,198	1,280	326	681	137	36	16

Colorado.—The survey of the northwest quarter of the Pagoda quadrangle, in Moffat and Routt counties, was continued by D. H. Watson and C. H. Stewart, the area mapped being 136 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this area Mr. Stewart ran 47 miles of primary levels and established 12 permanent bench marks. For the control of the Pagoda and Elkhead quadrangles, in Garfield, Moffat, Rio Blanco, and Routt counties, C. B. Kendall occupied 12 triangulation stations and marked 7. The mapping of the Del Norte quadrangle, lying partly in the Rio Grande and Cochetopa national forests, in Alamosa, Rio Grande, and Saguache counties, was completed and that of the Naturita and Home quadrangles, lying partly in the

La Sal, Arapahoe, and Colorado national forests, in Montrose, San Miguel, Jackson, and Larimer counties, was continued by Basil Duke, R. C. Seitz, C. L. Nelson, W. F. Hicks, C. A. Ecklund, and Cornelius Schnurr, the total area mapped being 1,531 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 415 square miles is within the national forests. For the control of the Naturita quadrangle R. W. Burchard ran 37 miles of primary levels and established 10 permanent bench marks, and in connection with the mapping of this area Mr. Nelson made a profile survey of Dolores River, the distance traversed being 19 linear miles, for publication on the scale of 1:48,000. For the control of the Home quadrangle Mr. Kendall and G. R. Ruby occupied 12 triangulation stations and marked 1.

A survey for the location of the Fall River Road, in the Rocky Mountain National Park, was made by W. O. Tufts, all expenses of this work being borne by the Interior Department.

Minnesota.—See North Dakota, South Dakota, and Minnesota (p. 122).

Nebraska.—The mapping of the Humboldt quadrangle, in Richardson County, was completed by S. H. Birdseye and F. W. Crisp, the area mapped being 228 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area Mr. Birdseye ran 45 miles of primary levels and established 12 permanent bench marks, and Mr. Birdseye and Mr. Crisp ran 54 miles of primary traverse and set 17 permanent marks.

New Mexico.—The mapping of the Koehler quadrangle, in Colfax and Union counties, was completed by R. W. Berry, the area mapped being 240 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. The mapping of the Reserve quadrangle, lying wholly in the Datil and Socorro national forests, in Socorro County, was completed and that of the Patterson quadrangle, lying partly in the Datil National Forest, in Socorro County, was begun by C. C. Gardner, S. T. Penick, and R. W. Burchard, the total area mapped being 1,065 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 682 square miles is in the national forests. For the control of the Patterson quadrangle C. B. Kendall occupied 8 triangulation stations and marked 5, and Mr. Burchard ran 119 miles of primary levels and established 31 permanent bench marks.

Profile surveys were made of the Rio Grande from the Colorado and New Mexico State line to Embudo and from Ildefonso to Pena Blanca, and of Pecos, Gila, and Mora rivers, lying partly in the Rio Grande, Carson, Pecos, and Gila national forests, in Taos, Rio Arriba, Sandoval, Santa Fe, San Miguel, Grant, and Mora counties, the total distance traversed being 211 linear miles, for publication on the scale of 1:31,680, with 5 and 25 foot contour intervals. Of this distance 34 miles is in the national forests. In connection with the survey of Gila River reservoir sites covering 28 square miles were mapped, for publication on the scale of 1:31,680. This work was done by R. C. Seitz and C. R. Fisher.

The revision of the map of the Tyrone district, in Grant County, was begun by O. G. Taylor, the area covered being 8 square miles.

Oklahoma.—For the control of the Gray Horse, Kaw, Belford, and Foraker quadrangles, in Osage, Pawnee, Kay, and Noble counties, B. H. Yoakum ran 162 miles of primary traverse and set 23 permanent bench marks. The revision of the mapping of the roads in the Hominy quadrangle was begun by C. C. Holder.

North Dakota, South Dakota, and Minnesota.—The mapping of the New Effington and White Rock quadrangles, in Roberts County, S. Dak., Richlands County, N. Dak., and Traverse County, Minn., was completed and that of the Peever quadrangle, in Roberts County, S. Dak., and Big Stone and Traverse counties, Minn., was begun by C. E. Cooke, S. P. Floore, and A. J. Kavanagh, the total area mapped being 497 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. Of this area 299 square miles is in South Dakota, 98 square miles in North Dakota, and 100 square miles in Minnesota. For the control of these areas G. T. Hawkins and Mr. Kavanagh ran 195 miles of primary traverse and set 22 permanent marks—104 miles and 10 marks in South Dakota, 15 miles and 3 marks in North Dakota, and 76 miles and 9 marks in Minnesota—and Mr. Kavanagh ran 221 miles of primary levels and established 48 permanent bench marks—134 miles and 38 marks in South Dakota, 33 miles and 9 marks in North Dakota, and 54 miles and 1 mark in Minnesota.

Texas.—For the continuation of cooperative topographic mapping in Harris County the county allotted $35,000 and the United States Geological Survey alloted $5,000. The mapping of the Deepwater, Webster, Addicks, Harmaston, Cypress, Ashford, Aldine, and Hillendahl quadrangles, of the Harris County portions of the Almeda, Alief, Mykawa, Sugarland, Holik, Huffman, Joseph, Hockley, Clodine, Katy, Trinity Bay, Gaston, Seabrook, Waller, and Swanson quadrangles, and of the portions of the Park Place, Bellaire, Houston Heights, and Settegast quadrangles outside of the city of Houston was completed and that of the La Porte, Rose Hill, Louetta, Spring, Weeden, Pauli, Burnett Bay, and Humble quadrangles was begun, the area mapped being 1,310 square miles, for publication on the scale of 1:31,680, with contour intervals of 1 and 5 feet. This work was done by C. H. Birdseye, B. A. Jenkins, W. B. Lewis, E. R. Bartlett, A. J. Ogle, Olinus Smith, T. H. Moncure, O. H. Nelson, S. T. Penick, H. W. Peabody, J. H. Wilke, J. B. Leavitt, L. B. Roberts, T. P. Pendleton, C. C. Holder, Cornelius Schnurr, F. A.

Danforth, D. H. Watson, R. R. Monbeck, C. A. Stonesifer, and F. W. Hicks. For the control of the Deepwater, Park Place, Mykawa, Seabrook, Webster, Settegast, Weeden, Pauli, Fauna, Huffman, Burnett Bay, New Caney, Scott Ranch, Waller, Stilson, Spring, La Porte, Cedar Bayou, Morgans Point, Crosby, Walley, Louetta, Hempstead, Brenham, Brookshire, Sealy, and Humble quadrangles E. L. McNair, F. W. Hicks, and D. S. Birkett ran 270 miles of primary traverse and set 75 permanent bench marks. For the control of the Deepwater, Park Place, Mykawa, Katy, Seabrook, Webster, La Porte, Cedar Bayou, Morgans Point, Crosby, Walley, Hockley, Rose Hill, Louetta, Spring, Houston Heights, Settegast, Stuebner, Weeden, Pauli, Fauna, Huffman, Burnett Bay, Harmaston, Waller, Hempstead, Brenham, Brookshire, Sealy, Cypress, Ashford, Aldine, Humble, and Hillendahl quadrangles R. R. Monbeck and D. S. Birkett ran 525 miles of primary levels and established 147 permanent bench marks.

In addition to the cooperative work, the mapping of the Burkburnett, Clara, and Barwise School quadrangles, in Wichita County, was completed and that of the Electra and Wichita Falls quadrangles, in Wichita County, was begun by R. W. Berry, R. H. Reineck, C. A. Ecklund, Cornelius Schnurr, K. W. Trimble, and D. H. Watson, the area mapped being 208 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of these areas and of the Beaver Creek, Fowlkes, Iowa Park, and Wichita Falls quadrangles, in Wichita County, Mr. Watson and C. R. Fisher ran 120 miles of primary levels and established 33 permanent bench marks.

Wyoming.—The mapping of the Moorcroft and Como Ridge quadrangles, in Crook, Weston, Albany, and Carson counties, was completed and that of the Smoot quadrangle, lying partly in the Wyoming National Forest, in Lincoln County, was begun by R. H. Reineck, J. H. Wilke, F. W. Crisp, C. R. Fisher, and G. M. Ruby, the total area mapped being 955 square miles, 733 square miles for publication on the scale of 1:125,000, with contour intervals of 50 and 100 feet, and 222 square miles for publication on the scale of 1:62,500, with a contour interval of 50 feet. Of this area, 65 square miles lies in the national forest. For the control of these areas Mr. Crisp, Mr. Fisher, Mr. Ruby, and D. S. Birkett ran 166 miles of primary levels and established 33 permanent bench marks. For the control of the Medicine Bow quadrangle, in Albany and Carson counties, G. T. Hawkins occupied four triangulation stations and marked three.

OFFICE WORK.

The drafting of the following topographic maps was completed: Del Norte, Colo.; Humboldt, Nebr.; Koehler, Reserve, and Mogollon mining district, N. Mex.; New Effington, S. Dak.-N. Dak.; White Rock, S. Dak.-N. Dak.-Minn.; Addicks, Alief, Sugarland, Almeda, Barwise School, Bellaire, Burkburnett, Clara, Clodine, Cypress, Deepwater, Hillendahl, Houston Heights, Katy, Gaston, Mykawa, and Park Place, Tex.; Como Ridge and Moorcroft, Wyo.

The drafting of profile sheets of the following rivers was completed: Dolores, Colo.; Gila, Mora, Pecos, Rio Grande from Colorado to Embudo, and Rio Grande from Ildefonso to Pena Blanca, N. Mex.

Progress in the drafting of additional sheets was made as follows: Home, Colo., 90 per cent; Naturita, Colo., 39 per cent; Pagoda (northwest quarter), Colo., 50 per cent; Drummond, Mont., 33 per cent; Patterson, N. Mex., 35 per cent; Swanson, Tex., 50 per cent.

Primary-level circuits were adjusted for the following quadrangles: Pagoda, Colo.; Falls City and Humboldt, Nebr.; Ray, N. Dak.; Patterson, N. Mex.; New Effington and White Rock, S. Dak.; Aldine, Alief, Almeda, Archer City, Ashford, Bellaire, Bobbin, Burkburnett, Burnett Bay, Cedar Bayou, Crosby, Cypress, Dallas, Deepwater, Eschite, Fauna, Harmaston, Hillendahl, Hockley, Holik, Houston Heights, Huffman, Humble, La Porte, Louetta, Morgans Point, Mykawa, Park Place, Pauli, Rose Hill, Rosenburg, Scotts Ranch, Seabrook, Settegast, Spring, Stuebner, Swanson, Waller, Walley, Webster, and Weeden, Tex.

Geographic positions were computed for the following quadrangles: Boulder, Eagle, Glenwood Springs, Home, Kremmling, Leon Peak, Livermore, Longs Peak, Mount Powell, Pagoda, Rabbit Ears, Rifle, and Snow Mass, Colo.; Beardsley, Minn.; New Effington, N. Dak.; Humboldt, Nebr.; Patterson, N. Mex.; Beardsley, New Effington, and Peever, S. Dak.; Aldine, Alief, Almeda, Ashford, Bellaire, Burnett Bay, Cedar Bayou, Crosby, Cypress, Deepwater, Fauna, Harmaston, Hillendahl, Hockley, Holik, Houston Heights, Huffman, Humble, La Porte, Louetta, Morgans Point, Mykawa, Park Place, Pauli, Rose Hill, Scotts Ranch, Seabrook, Settegast, Spring, Stuebner, Swanson, Waller, Walley, Webster, and Weeden, Tex.

NORTHWESTERN DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Idaho, Montana, Oregon, and Washington. The work comprised the completion of the survey of 7 quadrangles, in addition to which 9 quadrangles were partly surveyed. The total new area mapped was 4,405 square miles, 3,747 square miles for publication on the scale of 1:125,000, 534 square miles for publication on the scale of 1:62,500, and 124 square miles for publication on the scale of 1:31,680. In addition, the revision of the map of part of one quadrangle was completed, this revision covering 90 square miles. In connection with this work 516 miles of primary levels were run and 120 permanent bench marks were established. Profile surveys were made of two rivers, the distance traversed being 261 linear miles, in connection with which 37 square miles were surveyed for publication on the scale of 1:31,680.

Primary triangulation was carried on by four parties in Idaho and Washington. The total area covered by this work was 6,840 square miles, 77 triangulation stations being occupied and 59 marked. This work made control available in 21 quadrangles.

Topographic surveys in northwestern division from July 1, 1915, to June 30, 1916.

State.	Contour interval.	For publication on scale of—			Total area surveyed, new.	Primary levels.		Triangulation stations.	
		1:125,000.	1:62,500.	1:31,680.		Distance run.	Bench marks.	Occupied.	Marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*	
Idaho	5, 25, 50, 100	763	286	20	1,069	91	23	63	45
Montana	100	605	21	....	626	....	....	....	....
Oregon	5, 25, 50, 100	780	130	87	997	134	41	....	....
Washington	5, 25, 50, 100	1,599	97	17	1,713	291	56	14	14
		3,747	534	124	4,405	516	120	77	59

Idaho.—The mapping of the Cranes Flat quadrangle, in Bannock, Bingham, and Bonneville counties, was completed and that of the Custer quadrangle and of the southwest quarter of the Irwin quadrangle, in Bannock, Bonneville, and Custer counties, was begun by Albert Pike, C. G. Anderson, and F. L. Whaley, the area mapped being 376 square miles, 90 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet, and 286 square miles for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of these areas and of the Irwin, Portneuf, Henry, and Lanes Creek quadrangles and the southwest quarter of the Ammon quadrangle, in Bannock, Bingham, and Bonneville counties, H. H. Hodgeson occupied 16 triangulation stations and marked 7, and for the control of the Henry quadrangle and of the Custer and Bay Horse quadrangles, in Custer County, Mr. Whaley and E. M. Bandli ran 77 miles of primary levels and established 19 permanent bench marks. The mapping of the Preston quadrangle, lying partly in the Cache National Forest, in Bannock, Bear Lake, and Franklin counties, was completed by Albert Pike and Mr. Whaley, the area mapped being 673 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 235 square miles is in the national forest. For the control of this area and of the Argo, No. 1, Dickey, Crooks, Bay Horse, Hailey, Circular Butte, Nicholia, Rabbits Foot, Tilden, Edie, and Mackay quadrangles, lying partly in the Challis, Lemhi, Salmon, and Sawtooth national forests, in Bannock, Blaine, Power, Custer, Minidoka, Bingham, Jefferson, Fremont, Lemhi, and Lincoln counties, T. M. Bannon and D. S. Birkett occupied 47 triangulation stations and marked 38. For the control of the Bay Horse quadrangle, in Custer County, Mr. Bandli ran 14 miles of primary levels and established 4 permanent bench marks. A profile survey of Snake River was made by Mr. Anderson, the total distance traversed being 43 linear miles in Fremont County, for publication on the scale of 1:31,680, with contour intervals of 5 and 25 feet. In connection with this profile survey 20 square miles of reservoir site was surveyed.

Idaho and Montana.—The mapping of the St. Regis quadrangle, lying partly in the St. Joe, Lolo, and Cabinet national forests, in Shoshone County, Idaho, and Mineral and Sanders counties, Mont., was continued by J. E. Blackburn, the area mapped being 227 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 139 square miles is in the national forests. All this area is in Montana.

Montana.—The mapping of the Nameless quadrangle, in Valley County, was continued by R. C. Seitz, the area mapped being 21 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The mapping of the Drummond quadrangle, lying partly in the Deerlodge and Missoula national forests, in Granite, Missoula, and Powell counties, was begun by K. W. Trimble, the area mapped being 378 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 64 square miles is in the national forests.

Oregon.—For the continuation of cooperative topographic surveys the State engineer allotted $4,000 and the United States Geological Survey allotted an equal amount. In the survey of the Willamette Valley the mapping of the Salem quadrangle, in Marion and Polk counties, was completed by Fred Graff, jr., Charles Hartmann, and R. B. Kilgore, the area mapped being 87 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. The mapping of the Oregon portion of the Hillsboro quadrangle, in Columbia, Multnomah, and Washington counties, was completed and that of the Oregon portion of the southwest quarter of the Troutdale quadrangle and of the Twickenham quadrangle, in Multnomah, Crook, Jefferson, Wasco, and Wheeler counties, was begun by C. L. Sadler, Mr. Graff, A. O. Burkland, Mr. Hartmann, and Bishop Moorhead, the total area mapped being 187 square miles—130 square miles for publication on the scale of 1:62,500, with a contour interval of 25 feet, and 57 square miles for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of the Twickenham quadrangle and of the Heisler quadrangle, in Crook, Jefferson, and Wasco counties, D. S. Birkett ran 88 miles of primary levels and established 28 permanent bench marks.

In addition to the cooperative work, the mapping of the Kerby quadrangle, lying partly in the Siskiyou National Forest, in Curry and Josephine counties, was completed by J. G. Staack, A. O. Burkland, C. P. McKinley, R. M. Wilson, and John McCombs, the area mapped being 723 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this area L. F. Biggs ran 46 miles of primary levels and established 13 permanent bench marks.

Washington.—For the continuation of cooperative topographic surveys the Washington State Board of Geological Survey allotted $11,500 and the United States Geological Survey allotted an equal amount. The mapping of the Prosser and Wallula quadrangles, in Benton, Klickitat, Yakima, Franklin, and Walla Walla counties, was completed and that of the Walla Walla quadrangle, in Columbia and Walla Walla counties, was begun by C. L. Sadler, Albert Pike, H. L. McDonald, J. F. McBeth, and Charles Hartmann, the area mapped being 1,364 square miles—1,270 square miles for publication on the scale of 1:125,000, with a contour interval of 50 feet, and 94 square miles for publication on the scale of 1:62,500, with a contour interval of 50 feet. The remainder of these quadrangles, covering 195 square miles, was mapped by the Reclamation Service. In connection with the survey of the Prosser quadrangle the work of the Reclamation Service in that area, covering 90 square miles, was revised. For the control of these areas and of the Walla Walla, Pomeroy, and Winona quadrangles and the Washington portion of the Asotin quadrangle, in Walla Walla, Columbia, Garfield, Adams, Whitman, and Asotin counties, D. S. Birkett ran 172 miles of primary levels and established 42 permanent bench marks. A profile survey of Skagit River and tributaries above Concrete was made by S. G. Lunde, the distance traversed being 218 linear miles, for publication on the scale of 1:31,680. In connection with this work 17 square miles of reservoir site was surveyed, for publication on the scale of 1:31,680. The mapping of the Washington portion of the Hillsboro quadrangle, in Clarke County, was completed, the area mapped being 3 square miles, for publication on the same scale as the Oregon portion. For the control of the Connell and Riparia quadrangles, in Adams, Franklin, and Columbia counties, G. T. Hawkins occupied and marked 14 triangulation stations.

In addition to the cooperative work in Washington, the mapping of the Mount St. Helens quadrangle, lying partly in the Columbia National Forest, in Clarke, Cowlitz, Lewis, and Skamania counties, was continued by C. P. McKinley, E. M. Bandli, and L. V. Fees, the area mapped being 329 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 182 square miles is within the national forests. For the control of this area and of the Kalama quadrangle, in Cowlitz and Lewis counties, L. F. Biggs ran 119 miles of primary levels and established 14 permanent bench marks.

OFFICE WORK.

The drafting of the following topographic maps was completed: Cranes Flat and Preston, Idaho; Hillsboro, Kerby, and Salem, Oreg.; Prosser and Wallula, Wash.

The drafting of profile sheets of the following rivers was completed: Snake, Idaho; Skagit and tributaries above Concrete, Wash.

Progress in the drafting of additional sheets was made as follows: St. Regis, Idaho-Mont., 38 per cent; Mount St. Helens, Wash., 53 per cent.

Primary-level circuits were adjusted for the following quadrangles: Ammon and Preston, Idaho; Heisler, Kerby, and Twickenham, Oreg.; Kalama, Mount St. Helens, Pomeroy, Portland, Prosser, Riparia, St. Helens, Troutdale, Walla Walla, and Wallula, Wash.

Geographic positions were computed for the Arco, Argo, Bancroft, Bay Horse, Crooks, Custer, Dickey, Hailey, Henry, Mackay, Mink Creek, Nicholia, No. 1, Portneuf, Soda Springs, and Tilden quadrangles, Idaho.

PACIFIC DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Arizona, California, Nevada, and Utah. This work comprised the completion of the survey of 14 quadrangles and the resurvey of 3 quadrangles and 1 special area, in addition to which 11 quadrangles were partly surveyed and 3 were partly resurveyed. The total new area mapped was 2,808 square miles—1,493 square miles for publication on the scale of 1:125,000, 561 square miles for publication on the scale of 1:62,500, and 754 square miles for publication on the scale of 1:31,680. The area resurveyed was 798 square miles—728 square miles for publication on the scale of 1:62,500 and 70 square miles for publication on the scale of 1:31,680. The map of part of a quadrangle was revised to bring it up to date with the new work, the area covered by this revision being 250 square miles. In connection with this work 343 miles of primary levels were run and 87 permanent bench marks were established. In addition, profile surveys were made of portions of four rivers, the distance traversed being 113 linear miles.

Primary triangulation was carried on by three parties in California, Nevada, and Utah. The total area covered by this work was about 3,690 square miles, 89 triangulation stations being occupied and 94 marked. The result of this work was to make control available in 41 quadrangles.

Topographic surveys in Pacific division from July 1, 1915, to June 30, 1916.

State.	Contour interval.	For publication on scale of—					Total area surveyed.	Primary levels.		Triangulation.	
		1:125,000	1:62,500		1:31,680			Distance run.	Bench marks.	Stations occupied.	Stations marked.
		New.	New.	Resurvey.	New.	Resurvey.					
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*			
Arizona	100	546	....	....	....	....	546	56	11	....	....
California	5-25-100	947	561	6	754	70	2,338	57	14	51	61
Nevada	50	....	....	494	....	....	494	107	28	22	20
Utah	50	....	....	228	....	....	228	123	34	16	13
		1,493	561	728	754	70	3,606	343	87	89	94

Arizona.—The mapping of the Chiricahua quadrangle, lying partly in the Chiricahua National Forest, in Cochise County, Ariz., and Grant County, N. Mex., was begun by J. E. Blackburn, the area mapped being 546 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 144 square miles is in the national forest. For the control of this area C. R. Fisher ran 56 miles of primary levels and established 11 permanent bench marks. All this work was done in Arizona. Profile surveys were made of Verde and Salt rivers, in Yavapai and Gila counties, by Mr. Fisher, the distance traversed being 83 linear miles, for publication on the scale of 1 :31,680, with contour intervals of 5 and 25 feet.

California.—For the continuation of cooperative topographic surveys the California Department of Engineering allotted $14,000 and the United States Geological Survey allotted an equal amount. In the continuation of the survey of San Joaquin Valley the mapping of the Planada, Newman, Atwater, No. 7, No. 9, Stevinson, Arena, Gustine, Le Grand, and Ingomar 7½-minute quadrangles and of the valley portions of the No. 74, Merced Falls, and Orestimba Creek 7½-minute quadrangles, in Merced, Stanislaus, Tuolumne, Mariposa, and Madera counties, was completed, and that of the Plainsberg and Las Garzas Creek quadrangles and of the Indian Gulch 15-minute quadrangle, in Mariposa, Madera, Merced, and Stanislaus counties, was begun by E. P. Davis, R. T. Evans, A. J. Ogle, H. W. Peabody, J. H. LeFeaver, J. B. Leavitt, N. E. Ballmer, Roscoe Reeves, and R. M. Wilson, the area mapped being 844 square miles—754 square miles for publication on the scale of 1:31,680, with a contour interval of 5 feet, and 90 square miles for publication on the scale of 1:62,500, with a contour interval of 25 feet. The resurvey of the Snelling quadrangle and of the valley portion of the La Grange quadrangle, in Merced, Stanislaus, and Tuolumne counties, was completed by R. T. Evans, J. B. Leavitt, and Roscoe Reeves, the area mapped being 70 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of the Jamison, Fresno, Madera, No. 10, No. 14, No. 15, No. 16, No. 18, No. 19, No. 20, No. 21, No. 22, No. 23, No. 24, No. 25, Kerman, Kearney Peak, Kings River, Elgin, Chowchilla Slough, Center School, Dos Palos, Tranquillity, Oxalis, Firebaugh, Mendota, San Joaquin, Sanger, Wahtoke, Sultana, Sheep Ranch, and Chaney Ranch quadrangles and the Rudley special area, in Fresno, Madera, Merced, and Tulare counties, L. F. Biggs occupied 46 triangulation stations and marked 60. For the control of the Volta, Las Garzas Creek, Los Banos, and San Luis Creek quadrangles, in Merced and Stanislaus counties, Mr. Reeves ran 42 miles of primary levels and established 10 permanent bench marks.

In addition to the cooperative work in California, the survey of the Cholame, San Juan Bautista, and Morgan Hill quadrangles, in San Luis Obispo, Kings, Monterey, Fresno, Kern, San Benito, Santa Clara, and Santa Cruz counties, was completed and that of the New Almaden and Point Reyes quadrangles, in Santa Clara, Santa Cruz, and Marin counties, was begun by A. T. Fowler, J. P. Harrison, E. P. Davis, R. T. Evans, A. J. Ogle, Olinus Smith, H. W. Peabody, J. H. Le Feaver, C. A. Ecklund, C. P. McKinley, N. E. Ballmer, and J. B. Leavitt, the area mapped being 741 square miles—270 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet, and 471 square miles for publication on the scale of 1:62,500, with a contour interval of 25 feet. In connection with the mapping of the Cholame quadrangle part of the work previously done was revised to bring the entire map up to date. The area covered by this revision is 250 square miles. The mapping of the Preston Peak quadrangle, lying wholly in the Klamath and Siskiyou national forests, in Del Norte and Siskiyou counties, was completed by J. W. Muller and J. P. Harrison, the area mapped being 677 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this area Mr. Biggs ran 15 miles of primary levels and established 4 permanent bench marks. In connection with this work Frederick Rider made a profile survey of the South Fork of Smith River as far as Quartz Creek and of Klamath River, the total distance traversed being 30 linear miles, for publication on the scale of 1:48,000.

California and Nevada.—The resurvey of the Yellow Pine mining district, in Clark County, Nev., and San Bernardino County, Cal., was completed by N. E. Ballmer and Roscoe Reeves, the area mapped being 236 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. Of this area 6 square miles is in California. For the control of this area L. F. Biggs occupied 13 triangulation stations and marked 8, of which 5 were occupied and 1 marked in California, and ran 80 miles of primary levels and established 21 permanent bench marks, all in Nevada.

Nevada.—The resurvey of the Bristol Range quadrangle, in Lincoln County, was completed and that of the northwest quarter of the Panaca quadrangle and the northeast quarter of the Delamar quadrangle, in Lincoln County, was begun by H. H. Hodgeson, N. E. Ballmer, and Roscoe Reeves, the area mapped being 264 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. This work covers part of the Pioche district. For the control of this area Mr. Hodgeson occupied 14 triangulation stations and marked 13, and Mr. Reeves ran 27 miles of primary levels and established 7 permanent bench marks.

Utah.—The resurvey of the Fairfield quadrangle, in Salt Lake, Tooele, and Utah counties, was completed by A. T. Fowler and W. O. Tufts, the area mapped being 228 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this area and of the Mercur, Nephi, Mammoth, and Provo quadrangles, in Tooele, Utah, Salt Lake, Wasatch, Juab, Millard, and Sanpete counties, C. W. Urquhart occupied 16 triangulation stations and marked 13, and for the control of the Fairfield, Mercur, Saltair, and Dunstein quadrangles, in Salt Lake, Tooele, and Utah counties, Roscoe Reeves ran 123 miles of primary levels and established 34 permanent bench marks.

OFFICE WORK.

The drafting of the following topographic maps was completed: Christmas, Ariz.; Arena, Atwater, Cholame, Elizabeth Lake, Gustine, Morgan Hill, Newman, Orestimba Creek, Owens Creek, Planada, Preston Peak, San Juan Bautista, Snelling, and Stevinson, Cal.; Hilo, Hawaii; Bristol Range, Nev.; White Mountain, Nev.-Cal.; Fairfield, Utah.

The drafting of profile sheets of the following rivers was completed: Klamath and South Fork of Smith, Cal.

Progress in the drafting of additional sheets was made as follows: La Grange, Cal., 5 per cent; Le Grand, Cal., 5 per cent; New Alamaden, Cal., 15 per cent.

Primary-level circuits were adjusted for the following quadrangles: Crescent City and Preston Peak, Cal.; Bristol Range, Nev.; Yellow Pine mining district, Cal.-Nev.; Mercur and Saltair, Utah.

Geographic positions were computed for the following quadrangles: Pioche district (Bristol Range, Delamar, Ely Range, Newland, and Panaca), Nev.; Yellow Pine mining district, Cal.-Nev.; Merced, Planada, No. 11, Indian Gulch, Plainsberg, Le Grand, No. 9, Deadman Creek, Owens Creek, Chowchilla Slough, Mariposa Slough, Salt Slough, Ingomar, Las Garzas Creek, Berendo, Minturn, and No. 10, Cal.; Mercur, Utah; and Mount St. Helens, Wash.

INSPECTION OF TOPOGRAPHIC MAPPING.

W. M. Beaman spent four months and A. M. Walker one month in a field inspection of topographic mapping in the five topographic divisions. Mr. Beaman continued the supervision of the field and office work on the map of Washington and vicinity, and Mr. Walker spent four months in field work and two months in office work on this map.

The office duties of Messrs. Beaman and Walker consisted largely in the supervision of the preparation of all topographic field sheets and reports for publication and their proper transmission. L. S. Leopold continued as assistant under this section.

MILLIONTH-SCALE MAP OF THE UNITED STATES.

Of the work in progress last year on the 1:1,000,000 scale map of the United States, under the direction of A. F. Hassan, 90 per cent of the base map of Idaho (parts of sheets K–11, K–12, L–11, L–12, M–11) was completed. International sheets K–18 and J–18 were completed, and the base maps of Florida and North Carolina were revised. New work included the completion of the base map of an area comprising approximately one-third of Colorado (parts of sheets J–13 and K–13) and the compilation of 80 per cent of the township lines of the rest of the State, the compilation and inking of 60 per cent of the base map of the Coastal Plain area of Texas (sheets I–14, I–15, H–14, and H–15), and the completion of international sheet I–18.

The problem of showing relief by contours, generalized to meet the conditions imposed by the small scale so as to preserve legibility and still show topographic character, received much study, and a number of experimental drawings of intricately dissected plateau types were made.

WORK OF SECTION OF FIELD EQUIPMENT.

During the year this section continued the custody of field instruments and camp equipment, as well as office property in the Survey offices outside of Washington, for the geologic, topographic, and water-resources branches. The personnel and duties of the section remained unchanged during the year, consisting of E. M. Douglas in charge, Ernest Kubel in immediate charge of the instrument shop, two clerks, one skilled mechanic, and one laborer, with the occasional help of a second laborer.

The records of field instruments included 100 items and those of camp outfits 93 items. This year's inventory includes among the more important items 406 alidades, 837 compasses, 591 levels, 202 current meters, 107 registers, 226 leveling rods, 797 tapes, and 42 transits. Under camp outfits are listed 496 horses and mules, 8 automobiles, 6 boats and canoes, 2 well-drilling outfits, 709 pack and riding saddles, 525 tents, and 162 buckboards and wagons.

The topographic record books are also in the custody of this section, and during the year 430 vertical and horizontal control books, 193 vertical-angle record books, and about 50 envelopes of manuscript were catalogued and filed.

In the instrument shop repairs were made to over 2,000 instruments, including 107 telescopic alidades, 30 Y levels, 25 transits, and 180 compasses. The instrument shop also made, resurfaced, or electrotyped over 152,000 square inches of plates.

WATER-RESOURCES BRANCH.

ORGANIZATION AND SCOPE OF WORK.

The water-resources branch includes three divisions—surface water, ground water, and water utilization—each of which is subdivided into sections for field work. The organization is as follows:

Chief of branch, N. C. Grover, chief hydraulic engineer.

Division of surface waters, J. C. Hoyt, hydraulic engineer, in charge.

Division of ground waters, O. E. Meinzer, geologist, in charge.

Division of water utilization, N. C. Grover, chief hydraulic engineer, in charge.

PERSONNEL.

During the year the technical force of the water-resources branch has been reduced 14 by transfers and resignations and has been increased 8 by new appointments. At the end of the year the force consisted of 1 chief hydraulic engineer, 12 hydraulic engineers, 25 assistant engineers, 24 junior engineers, 1 geologist, 2 associate geologists, 3 assistant geologists, 1 geologic aid, and 1 chemist, a total of 70. Of this number, 1 hydraulic engineer, 1 assistant engineer, and 1 junior engineer are on furlough, and 1 hydraulic engineer, 3 assistant engineers, and 1 assistant geologist are employed occasionally.

In the clerical force there were 4 separations and 3 accessions, and at the end of the year it numbered 25 members.

ALLOTMENTS.

The appropriation was the same as in the preceding year—$150,000. The cooperative funds made available by State allotments have been increased in some States and decreased in others, making necessary corresponding adjustments of the work.

The appropriation for the fiscal year was allotted as follows:

Administrative expenses of the Survey		$10,624
Branch administration		7,280
Computations and reports		18,000
Inspection		1,000
Stream gaging:		
New England States	$4,500	
New York	2,500	
Virginia and Maryland	600	
South Atlantic and Gulf States	4,500	
Texas	3,335	
Ohio Valley	6,000	
Upper Mississippi Valley States	5,500	
Colorado, Wyoming, and New Mexico	8,500	
Montana	4,000	
Utah	4,000	
Nevada	2,500	
Idaho	4,000	
Oregon	4,000	
Washington	4,000	
California	4,000	
Arizona	3,500	
Hawaii	4,500	
Yellowstone National Park	200	
		70,135
Investigation of ground waters, including quality of waters		19,000
Land-classification board		11,000
Water-power investigations		11,000
Contingent		1,961
		150,000

Of the total appropriation, 64 per cent was allotted for work in public-land States.

COOPERATION.

States.—Cooperative funds were allotted by several States, as follows:

Alabama		$200
Arizona		3,960
California:		
State engineer	$9,000	
State Water Commission	3,630	
City of San Francisco	3,930	
		16,560
Colorado		485
Connecticut		1,555
Hawaii		20,090
Illinois		2,355
Iowa		500
Kentucky		315

Maine		$4,515
Massachusetts		2,520
Minnesota		2,400
Montana		2,875
Nevada		3,140
New York:		
State engineer	$1,560	
Conservation Commission	12,240	
		13,800
North Dakota		500
Oregon		7,300
Texas		8,500
Utah		5,015
Vermont		1,440
Washington		6,020
Wisconsin		6,000
Wyoming		5,010

The work done under cooperative agreements in the several States has been limited to stream gaging, except as indicated below.

In California, in addition to a large amount of stream gaging, investigations of ground waters were continued in San Jacinto and Santa Clara valleys and in San Diego County, and measurements of depths to ground-water level were made in southern California. The report on the ground water of Sacramento Valley, based on work which has been in progress for several years, was practically completed.

In Connecticut the cooperative work consisted chiefly of ground-water surveys.

In Hawaii, besides stream gaging, measurements of precipitation were made, and the water losses in irrigation canals were studied.

The stream-flow records in Oregon, compiled in cooperation with the State, were published as Water-Supply Paper 370.

A compilation of stream-flow records in Massachusetts is now in press as Water-Supply Paper 415.

A detailed study of the water supply and the present and possible future use of Sevier River, Utah, begun in 1914, was still in progress at the end of the fiscal year.

In addition to the cooperative work tabulated above, in which the States furnished a part of the money for examinations made by the Survey staff, investigations of ground waters in Arizona were continued as in previous years in cooperation with the State Agricultural Experiment Station, analyses of water being made at the experiment station. An investigation of the ground waters of Montana was also begun in cooperation with the State engineer, who collected well records throughout the State, and with the State Board of Health and Montana State College, at the chemical laboratory of which analyses of water were made.

Reclamation Service.—Cooperation with the Reclamation Service in stream gaging has been continued. The gaging stations operated at the expense of the reclamation fund are on streams that are to furnish water to reclamation projects under construction by that Service. The field work of stream gaging is done by Survey engineers who are engaged in such work in the locality, and repayment of actual cost is made by the Reclamation Service through a transfer of funds.

Office of Indian Affairs.—Stream gaging was continued on the following Indian reservations, in accordance with authorizations of the Office of Indian Affairs: Colville, Crow, Fort Hall, Klamath, La Pointe, Menominee, Pine Ridge, Quinault, Rosebud, San Carlos, Standing Rock, Warm Springs, Yakima, and Duck Valley.

United States Engineer Office.—Stream gaging in connection with navigation and flood studies in the Ohio River basin is in progress in cooperation with the United States Engineer Office.

Forest Service.—A study of the stream flow in the Angeles National Forest, in southern California, is in progress in cooperation with the Forest Service.

City of San Francisco.—Stream gaging has been continued on Tuolumne River in cooperation with the city of San Francisco in connection with the utilization of the water to be stored in the Hetch Hetchy Valley as a water supply for the city.

PUBLICATIONS.

The publications of the year prepared by the water-resources branch comprised 24 reports and 9 separate chapters. Titles and brief summaries of these publications are given on pages 31–36. At the close of the year 24 other reports were in press and 8 manuscripts were awaiting editorial work.

GENERAL SUMMARY.

In the investigation of surface waters the water-resources branch has maintained gaging stations for measuring the discharge of streams in 39 States and in Hawaii and Alaska. It is, however, only through extensive cooperation with States and other Federal organizations that the relatively large amount of work now in progress can be carried on. Twenty-four cooperating States (including Hawaii) have contributed more than $115,000 for work in those States, and the Indian Office, Engineer Office, Reclamation Service, and Forest Service have also cooperated largely in the study of the flow of particular rivers. The cooperating States include, besides many of the Northern and Eastern States, all the States in the Great Basin and on the Pacific slope and nearly all those in the Rocky Mountain and western Gulf groups, where water is necessary for agriculture by irrigation.

Investigations of ground water have been made in 17 States (including Alaska), but the lack of funds prevents the comprehensive study of the occurrence, quantity, and quality that is commensurate with the importance of the subject. Several water-supply papers containing the results of ground-water investigations are published each year.

Many investigations of the present and probable future use of both surface and ground waters have been made in connection with the classification of the public lands, with special reference to their use for power under permit or for agriculture under the enlarged-homestead, desert-land, or Carey acts. The results of such investigations are generally incorporated in unpublished special reports to the Commissioner of the General Land Office and to the Secretary of the Interior.

DIVISION OF SURFACE WATERS.

ORGANIZATION.

The work of the division of surface waters consists primarily of the measurement of the flow of rivers but includes also special investigations of conditions affecting stream flow and utilization of the streams. In carrying on the work the United States is divided into 16 districts, including Hawaii. One of these districts (Texas) was established during the year, having been formed by dividing the South Atlantic district. The following list gives the districts, names of district engineers, and location of offices:

New England: C. H. Pierce, Customhouse, Boston, Mass.
New York: C. C. Covert, Federal Building, Albany, N. Y.
Middle Atlantic: G. C. Stevens, Washington, D. C.
South Atlantic and eastern Gulf: W. E. Hall, Federal Building, Atlanta, Ga.
Texas: G. A. Gray, Old Post Office Building, Austin, Tex.
Ohio Valley: A. H. Horton, Federal Building, Newport, Ky.[1]
Upper Mississippi River: W. G. Hoyt, Capitol Building, Madison, Wis.; suboffice, Old Capitol Building, St. Paul, Minn.
Upper Missouri: W. A. Lamb, Montana National Bank Building, Helena, Mont.
Rocky Mountain: Robert Follansbee, New Post Office Building, Denver, Colo.
Great Basin: E. A. Porter (to February 29), C. C. Jacob (after February 29), Federal Building, Salt Lake City, Utah.
Idaho: G. C. Baldwin, Idaho Building, Boise, Idaho.
Oregon: F. F. Henshaw, Couch Building, Portland, Oreg.
Washington: G. L. Parker, Federal Building, Tacoma, Wash.
California: H. D. McGlashan, Customhouse, San Francisco, Cal.; suboffice, Federal Building, Los Angeles, Cal.
Arizona: C. C. Jacob (to February 29), M. D. Anderson, acting (after February 29), Fleming Building, Phoenix, Ariz.
Hawaii: G. K. Larrison, Kapiolani Building, Honolulu.

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[1] Office temporarily closed during the year; work conducted from Washington office.

CHARACTER AND METHODS OF WORK.

Field investigations incident to the work are made from the district offices, where the results are sufficiently analyzed to insure their accuracy and completeness. At selected places, known as gaging stations, measurements of discharge are made and other data are collected from which the daily flow of the streams is computed. At the end of the year 1,302 gaging stations were maintained, including 100 in Hawaii and 9 in Alaska. During the year 384 stations were discontinued and 327 stations established. In addition, records ready for publication were received for about 150 stations from other Government bureaus and private persons. During the year 8,271 measurements of discharge were made. Many of the stations are maintained in cooperation with other Federal bureaus, State organizations, or private persons.

Gaging stations and cooperating parties for the year ended June 30, 1916.

State.	Geological Survey alone.	Reclamation Service.	Forest Service.	Indian Service.	Army engineers.	Weather Bureau.	Other Federal bureaus.	State cooperation.	Municipal cooperation.	Private persons.	Counted more than once.	Maintained at end of year.	Established during year.	Discontinued during year.	Regular gagings during year.	Miscellaneous gagings during year.
Alabama	....	....	....	....	1	....	....	4	....	....	....	5	....	....	8	....
Arizona	....	....	....	4	2	....	....	19	....	2	4	23	5	6	306	31
California	....	....	36	2	....	2	7	147	17	42	106	147	19	44	1,087	299
Colorado	5	3	24	....	....	1	....	13	....	3	2	47	4	6	252	1
Connecticut	....	....	....	....	....	....	....	1	....	1	....	2	1	....	4	....
Georgia	1	....	....	....	....	4	....	....	3	14	1	21	5	2	96	1
Idaho	5	16	4	11	....	2	....	....	....	33	1	70	19	13	454	31
Illinois	....	....	....	....	....	1	....	23	....	....	....	24	2	3	81	1
Indiana	....	....	....	....	....	1	....	....	....	1	....	2	....	....	2	....
Iowa	....	....	....	....	....	2	....	14	....	....	2	14	....	....	23	....
Kentucky	....	....	....	....	....	....	....	5	....	....	....	5	....	1	5	....
Maine	....	....	....	....	....	....	....	16	....	2	2	16	4	10	66	....
Maryland	3	....	....	....	....	....	....	....	....	....	....	3	....	....	7	....
Massachusetts	....	....	....	....	....	....	....	17	....	1	1	17	7	7	85	2
Michigan	....	....	....	....	....	....	....	....	1	1	....	2	....	3	....	....
Minnesota	....	....	....	....	2	2	1	30	....	1	6	30	3	1	168	2
Montana	11	56	14	7	....	1	....	21	....	1	1	110	3	5	480	25
Nevada	....	2	....	2	....	1	....	41	....	14	18	42	13	13	169	65
New Hampshire	....	....	....	....	....	....	....	....	....	4	....	4	....	1	24	....
New Jersey	1	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....
New Mexico	1	....	....	2	....	....	....	....	....	4	....	7	....	23	17	....
New York	....	....	....	....	1	4	....	51	1	5	11	51	12	1	405	15
North Carolina	2	....	....	....	....	1	....	....	....	6	....	9	....	2	13	....
North Dakota	....	....	....	1	....	....	....	5	....	....	....	6	....	2	38	....
Ohio	1	....	....	....	5	....	....	....	....	....	....	6	....	2	13	....
Oklahoma	....	4	....	....	....	....	....	....	....	....	....	4	....	....	5	....
Oregon	....	....	5	8	....	4	1	26	3	73	1	119	100	69	354	148
Rhode Island	....	....	....	....	....	....	....	....	....	1	....	1	....	....	12	....
South Carolina	....	....	....	....	....	....	1	....	....	....	....	1	....	....	7	....
South Dakota	....	....	....	4	....	....	....	....	....	1	....	5	....	1	29	....
Tennessee	1	....	....	....	....	2	....	....	....	5	....	8	4	5	54	2
Texas	....	....	....	....	....	6	....	33	1	3	10	33	25	5	331	13
Utah	....	4	2	....	....	....	....	124	....	95	101	124	54	61	1,098	156
Vermont	....	....	....	....	....	....	....	9	....	4	4	9	2	1	67	1
Virginia	7	....	....	....	....	1	....	....	....	2	....	10	....	3	8	....
Washington	5	1	8	12	....	....	....	4	2	30	1	61	4	31	354	57
West Virginia	22	....	....	....	17	1	....	....	....	2	....	42	5	2	58	2
Wisconsin	....	....	....	3	....	....	....	44	....	12	15	44	4	6	250	1
Wyoming	....	8	2	....	....	1	4	55	....	1	3	68	9	3	292	1
Hawaii	....	....	....	....	3	....	....	100	....	48	51	100	23	52	585	106
	65	94	95	56	31	37	14	802	28	412	341	1,293	327	384	7,307	964

Results of field data collected from the district offices are transmitted to the Washington office, where they are reviewed in the computing section and prepared for publication. This review insures accuracy in the data and brings the results from different parts of the country to a uniform standard. Regular field inspections are made, and through annual conferences of the engineers the work in the several districts is standardized.

PUBLICATIONS.

For convenience and uniformity in publication the United States has been divided into 12 primary drainage basins, as shown in the following table, and the results of stream measurements are published annually in a series of progress reports that correspond to these 12 divisions. Prior to 1914 the records for each division were contained in a single water-supply paper; since 1914 the reports for the twelfth division have been published as three separate papers.

In 1913 a seasonal or climatic year—October 1 to September 30—was adopted for the presentation of reports on regions west of the Rocky Mountains and on the upper Mississippi and Ohio rivers; in 1914 the use of the climatic year was extended to all districts.

Numbers of water-supply papers containing results of stream measurements, 1910–1515.

Part.	Area.	1910	1911	1912	1913	1914	1915
I	North Atlantic	281	301	321	351	381	401
II	South Atlantic and eastern Gulf of Mexico	282	302	322	352	382	402
III	Ohio River	283	303	323	353	383	403
IV	St. Lawrence River and Great Lakes	284	304	324	354	384	404
V	Hudson Bay and upper Mississippi River	285	305	325	355	385	405
VI	Missouri River	286	306	326	356	386	406
VII	Lower Mississippi River	287	307	327	357	387	407
VIII	Western Gulf of Mexico	288	308	328	358	388	408
IX	Colorado River	289	309	329	359	389	409
X	Great Basin	290	310	330	360	390	410
XI	California	291	311	331	361	391	411
XII	North Pacific	292	312	332	362	......	......
	Pacific basins in Washington and upper Columbia River	......	......	332-A	362-A	392	412
	Snake River basin	......	......	332-B	362-B	393	413
	Lower Columbia River and Pacific basins in Oregon	......	......	332-C	362-C	394	414

In addition to the regular progress reports, special reports on various hydraulic subjects have been completed for publication during the year, as is indicated in the list on pages 31–36.

DIVISION OF GROUND WATERS.

SCOPE OF WORK.

The function of the division of ground waters is to make a survey of the waters that occur below the surface of the ground with reference to their utilization. Because of the great interest throughout the West in irrigation with ground water and the prospects for considerable developments of this kind, most of the work has been done in the arid and semiarid States and with special reference to irrigation.

During the year 41 investigations of ground water or quality of water (including the reports in press) were in progress, covering areas in Alaska, Arizona, Arkansas, California, Connecticut, Florida, Georgia, Mississippi, Montana, Nebraska, Nevada, New Mexico, Ohio, South Dakota, Texas, Wisconsin, Wyoming, and the United States naval station in Cuba. Of these investigations 8 were conducted in cooperation with the geologic branch of this Survey, 6 were made for and in part paid for by other branches of the Federal Government, including the Navy Department, the War Department, the Department of Justice, and the Office of Indian Affairs, and 20 were made in cooperation with State organizations, including 2 geological and natural history surveys, 2 departments of engineering, 2 experiment stations, 1 agricultural college, and 1 board of health.

A paper entitled "The divining rod, a history of water witching, with a bibliography," was prepared by A. J. Ellis and is to be published as Water-Supply Paper 416.

A bibliography and index of ground-water papers published by the United States Geological Survey was begun by O. E. Meinzer. Plans have also been made for a comprehensive manual on ground water.

The chemical investigations, which are under the supervision of R. B. Dole, cover both surface and ground waters. Some progress was made during the year in the preparation of a report on the chemical composition of the surface waters of the United States by Mr. Dole, assisted by A. A. Chambers. The chapter on the production of mineral waters for the annual volume Mineral Resources of the United States was prepared by Mr. Dole.

Maps and manuscripts for geologic folios were reviewed so far as they relate to ground water.

WORK BY STATES.

Alaska.—Through cooperation with the division of Alaskan mineral resources an investigation of the mineral springs in Alaska was made by G. A. Waring, and samples of water were also collected by him from Yukon River. The analytical work was done by R. B. Dole, A. A. Chambers, and S. C. Dinsmore. A report based on this investigation by Mr. Waring, with a chapter on the quality of waters by Messrs. Dole and Chambers, has been completed and will be published as Water-Supply Paper 418.

Arizona.—The report on the Navajo country, a geographic and hydrographic reconnaissance of parts of Arizona, New Mexico, and

Utah, by H. E. Gregory, is in press as Water-Supply Paper 380. A brief report on ground water in an area west of Little Colorado River is being prepared by Prof. Gregory. Both reports are based on investigations made in previous years through financial cooperation by the Office of Indian Affairs.

The report on ground water in Paradise Valley, by O. E. Meinzer and A. J. Ellis, was published as Water-Supply Paper 375–B.

A report on an investigation made in the fall of 1914 of the ground-water conditions in the San Carlos Reservation was completed by A. T. Schwennesen. This investigation was made in order to advise the Office of Indian Affairs with respect to sinking test wells to develop artesian supplies for irrigation. The report was transmitted in manuscript to the Indian Office.

An investigation of the artesian and other ground-water conditions in San Simon Valley, Ariz. and N. Mex., was begun in December, 1913, and several series of measurements of discharge and pressure of the artesian wells have been made since that date. In the summer of 1915 A. T. Schwennesen made a systematic ground-water survey of this valley and of the San Bernardino Valley, Ariz., which lies farther south. A preliminary report on the San Simon Valley is now in preparation. A comprehensive report on both valleys and of the Gila Valley from San Simon Valley to San Carlos is also being prepared by Mr. Schwennesen.

Through cooperation with the Arizona Agricultural Experiment Station the water analyses in connection with the Paradise Valley, San Carlos, and San Simon investigations were made by A. E. Vinson, of the Experiment Station staff.

Arkansas.—The report on the geology and ground waters of northeastern Arkansas, by L. W. Stephenson and A. F. Crider, with a discussion of the chemical character of the waters, by R. B. Dole, was published as Water-Supply Paper 399. This report was prepared in previous years in cooperation with the section of Coastal Plain investigations of the geologic branch.

California.—The final report on ground water in San Joaquin Valley, Cal., by W. C. Mendenhall, R. B. Dole, and Herman Stabler, was published as Water-Supply Paper 398.

A survey of the ground waters in the San Jacinto Valley, begun several years ago by W. C. Mendenhall and interrupted because of his duties as chief of the land-classification board, was resumed during the current year by G. A. Waring, and the report based on this survey was nearly completed.

An investigation of the ground water in the part of San Diego County lying west of the divide was begun by A. J. Ellis and C. H. Lee in September, 1914. Practically all the field work and most of the office work was completed by June 30, 1916. The results are to be embodied in a comprehensive report on the water resources of the county. The analytical work was done by S. C. Dinsmore. Financial cooperation was furnished by the city of San Diego.

During the year Kirk Bryan nearly completed a report on the Sacramento Valley, based on a ground-water survey begun in September, 1912.

Some progress was made during the year by W. O. Clark in the ground-water survey of the Santa Clara Valley, which was begun in August, 1912. The work was, however, interrupted because of another investigation that was assigned to Mr. Clark. At the request of the Department of Agriculture a special report was prepared by Mr. Clark on the ground-water supply of the Morgan Hill area, which lies in the Santa Clara Valley. This report is to be published as Water-Supply Paper 400–E. Levels were run by L. F. Biggs to determine the altitudes of observation wells in parts of the Santa Clara Valley.

Since 1900 measurements of depths to the water level in a series of wells in southern California have been made at intervals for the purpose of obtaining a record through many years of the relation between the contributions to the underground reservoirs in the rainy seasons and the withdrawals from them in the dry seasons, when ground water is pumped for irrigation and is withdrawn in large quantities by evaporation and transpiration. As in the previous year, these measurements were made by F. C. Ebert.

All the ground-water work in California is done in financial cooperation with the State Department of Engineering.

In response to a request from the War Department, a brief investigation to determine the possibility of developing ground-water supplies for the garrison on Angel and Alcatraz islands, in San Francisco Bay, was made in September, 1915, by G. A. Waring, and a report in manuscript was transmitted to the War Department on October 8.

Connecticut.—The report on ground water in the Hartford, Stamford, Salisbury, Willimantic, and Saybrook areas, Conn., by H. E. Gregory and A. J. Ellis, which was completed before the beginning of this fiscal year, was published as Water-Supply Paper 374.

The report on ground water in the Waterbury area, by A. J. Ellis, was published as Water-Supply Paper 397.

Observations in connection with an investigation of the relations between precipitation, ground-water storage, evaporation, run-off, and quality of water in the Pomperaug Valley, begun in July, 1913, by A. J. Ellis, were continued during the year, and considerable work was done in compiling the results. Porosity determinations and various field observations were made by O. E. Meinzer in July, 1915. Samples of well water were analyzed by S. C. Dinsmore, and daily samples from Nonewaug River were tested by A. A. Chambers for chlorine and carbonate.

A report on ground water in the Meriden area was practically completed by G. A. Waring, who had made the field survey of the area in the spring of 1915. Analyses of 25 samples of water were made by Mr. Dinsmore.

The ground-water survey in the Southington-Granby area, including the vicinity of Plainville and covering 18 towns, which was begun in the fall of 1914, was continued this year by H. S. Palmer, and on June 30, 1916, the report on this area prepared by Mr. Palmer was nearly completed. Analyses of 102 samples of water were made by Messrs. Dinsmore and Chambers.

All the work in Connecticut is done in cooperation with the State Geological and Natural History Survey under the supervision of H. E. Gregory.

Florida.—On account of the pressure of other work little progress was made in the investigation of the quality of ground waters in Florida begun in a previous year by R. B. Dole.

Examination of daily samples of sea water from Fowey Rocks Light, a study conducted in cooperation with the Bureau of Fisheries and T. W. Vaughan, of the geologic branch, for investigating certain phases of submarine deposition of limestone, was discontinued, and the results of the year's series of determinations of salinity were tabulated and discussed. The analyses were made by R. B. Dole, A. A. Chambers, C. D. Parker, and E. C. Bain.

Georgia.—A special investigation of the artesian waters which furnish the municipal supply for the city of Savannah, Ga., was made in the fall of 1915 by R. B. Dole, with special reference to sanitary problems. A manuscript report based on this investigation was transmitted to the city officials.

Mississippi.—A general investigation of the ground waters in Mississippi, begun in a previous year, was continued in cooperation with the section of Coastal Plain investigations of the geologic branch. (See p. 68.) The analytical work was supervised by Mr. Dole.

Montana.—A comprehensive investigation of the ground waters in Montana was begun in August, 1915, and a general survey of about 5,700 square miles of the Yellowstone River basin was made by A. J. Ellis, who is to continue the work in the ensuing year. This investigation is carried on in cooperation with State organizations. The chemical analyses are made by Carl Gottschalck at the laboratory of the State Board of Health and the Montana State College, under the supervision of W. M. Cobleigh, director of the laboratory. Records of wells were collected throughout the State by A. W.

Mahon, State engineer of Montana, in cooperation with W. A. Lamb, district engineer of the United States Geological Survey.

An investigation of the artesian water in the Little Bitterroot Valley, with special reference to its use for irrigation, was made in August, 1915, by O. E. Meinzer. Through cooperation with the State Board of Health and the Montana State College 10 samples of water from the valley were analyzed by Mr. Gottschalck. A report on the results of the investigation was completed by Mr. Meinzer and will be published as Water-Supply Paper 400–B.

Water-level measurements begun in 1912 in a well near Butte, in the Silverbow Valley, were continued during the year.

Nebraska.—In response to a request from the local irrigation association a brief special investigation of the ground-water supplies available for irrigation in the Lodgepole Valley, in Nebraska and Wyoming, was made in September, 1915, by O. E. Meinzer, and a report on the valley was partly prepared.

Nevada.—A preliminary report on ground water in the Big Smoky Valley, Nev., by O. E. Meinzer, was published as Water-Supply Paper 375–D. In the spring of 1915 additional discharge measurements of streams flowing into this valley were made by A. B. Purton, of the division of surface waters, chiefly for the purpose of ascertaining more definitely the amount of percolation into the underground reservoir. The water-level measurements begun in 1913 were continued during the year. The final report on the geology and water resources of Big Smoky, Clayton, and Alkali Spring valleys, by O. E. Meinzer, was sent to the printer and will be published as Water-Supply Paper 423.

An investigation of the ground-water conditions on the Truckee-Carson irrigation project, to determine the cause of the rise of the water levels in Big Soda and Little Soda lakes, was made for the Department of Justice by C. H. Lee and W. O. Clark. At the end of the fiscal year the report on this investigation was nearly completed.

New Mexico.—A report on ground water in the Animas, Playas, Hachita, and San Luis basins, in Grant County, N. Mex., was completed by A. T. Schwennesen. This report is based on field work done in 1913. Analyses of water samples and of the water-soluble contents of soil samples from these basins were made by R. F. Hare through cooperation with the New Mexico Agricultural Experiment Station.

The Navajo country, which was investigated by H. E. Gregory, and the San Simon Valley, which was investigated by A. T. Schwennesen, lie partly in New Mexico but more largely in Arizona. The ground-water surveys in these areas are described on pages 140–141.

Ohio.—In response to a request from the citizens of Canton, Ohio, a brief special investigation of the ground-water supplies available for municipal use in that city was made in March, 1916, by G. A. Waring. The results of this investigation were transmitted in manuscript to the Canton Chamber of Commerce.

South Dakota.—A report on the artesian water in the vicinity of the Black Hills, S. Dak., was prepared by N. H. Darton and is to be published as a water-supply paper. This report is a revision of earlier reports on the area by Mr. Darton and includes many new data.

Texas.—The work in Texas was done in cooperation with the section of Coastal Plain investigations of the geologic branch.

A report on the ground-water supply of Lasalle and McMullen counties, by Alexander Deussen and R. B. Dole, was published as Water-Supply Paper 375–G.

Work was continued on the ground-water resources of the part of the Texas Coastal Plain not covered by Water-Supply Paper 335, and two papers on this area are being prepared.

Wisconsin.—A report on the ground and surface water supplies of Wisconsin, which was prepared in previous years in cooperation with the Wisconsin Geological and Natural History Survey, by Samuel Weidman and A. R. Schultz, was published by the State as Bulletin 35 of the State Survey.

Wyoming.—A brief investigation of the ground waters available for irrigation in the Lodgepole Valley, which lies partly in Wyoming and partly in Nebraska, was made in September, 1915, by O. E. Meinzer, who is preparing a report on the area.

A special investigation for the purpose of assisting the city of Rawlins, Wyo., in developing ground water for a public supply was made by C. H. Wegemann, of the geologic branch, and a report in manuscript was transmitted to the city officials.

Cuba.—An investigation of the vicinity of Guantanamo Bay, Cuba, was made by O. E. Meinzer in November and December, 1915, for the purpose of advising the Navy Department in regard to sinking test wells to develop a water supply for the United States naval station situated on this bay. A manuscript report with geologic map of the reservation was transmitted to the Bureau of Yards and Docks.

DIVISION OF WATER UTILIZATION.

The organization of the division of water utilization has been continued during the year as described in previous annual reports. E. C. La Rue and E. C. Murphy, hydraulic engineers, have done the greater part of the field work involved in the examination of water-power withdrawals, rights of way, and Carey Act segregations. The work of examining land for designation under the enlarged-homestead act has been done in part by Messrs. La Rue and Murphy and in part by W. B. Heroy, geologist, and W. N. White, assistant classifier, in the land-classification board, who were detailed to the work during a part of the field season. Mr. Murphy has completed field examinations of the possibilities of water-power and reservoir development in Arizona and New Mexico, in order that lands valuable for such purposes may be designated in accordance with the act of Congress admitting Arizona and New Mexico to statehood.

Part 3 of the report on the water powers of the Cascade Range, covering the Yakima River basin, by G. L. Parker and F. B. Storey, was published as Water-Supply Paper 369, and Mr. La Rue's report on Colorado River and its utilization (Water-Supply Paper 395) was in press at the end of the year. Other reports containing the results of the work of the division of water utilization are Water-Supply Papers 376, 377, 378, and 379. Titles and brief summaries of these publications are given on page 34.

LAND-CLASSIFICATION BOARD.

ORGANIZATION.

The plan of organization of the land-classification board has not changed during the present year, remaining essentially as indicated in the last annual report. Such changes as have taken place are minor and are closely related to changes in personnel due to resignations or transfers. M. W. Ball, in charge of the oil section of the mineral division and the General Land Office cooperation, resigned at the end of March for transfer to the Bureau of Mines. After this resignation A. R. Schultz, geologist, was placed in charge of the division of mineral classification and E. H. Finch was made vice chairman of the phosphate section. Mr. Schultz will continue as chairman of the metalliferous section and W. B. Emery, vice-chairman, will act, under the direction of Mr. Schultz, as chairman of the oil section. The organization at the close of the year in outline is as follows:

W. C. Mendenhall, chief.

Elsie Patterson, secretary.

Division of mineral classification: A. R. Schultz, in charge of division. Coal section, G. H. Ashley, chairman; E. R. Lloyd, vice chairman. Oil section, W. B. Emery, vice chairman. Phosphate section, E. H. Finch, vice chairman. Metalliferous section, A. R. Schultz, chairman.

Division of hydrographic classification: Section of utilization, Herman Stabler, chairman. Section of classification, W. B. Heroy, chairman.

H. E. Grosbach and H. D. Padgett resigned during the year from the division of hydrographic classification, and R. M. Davis and C. E. Nordeen were added to the staff. Howard Clark, topographic engineer, was transferred to the land-classification board to assist the coal section as computer and draftsman.

The permanent force of the board at the close of the year included 6 geologists, 8 engineers, 18 clerks, 3 draftsmen, and 2 messengers, a total of 37 persons.

FUNDS.

Because of the reduction in the appropriation made for geologic work and the resulting necessity for curtailment of operations the allotments to the board for the year were reduced slightly below those of the preceding year. These allotments amounted for the year 1916 to $57,120 and were distributed among the general appropriations as follows:

Geologic surveys	$29,720
Topographic surveys	11,500
Gaging streams	11,000
Salaries of scientific assistants and skilled laborer	4,900
	57,120

SUMMARY OF WORK OF CLASSIFICATION.

As set forth elsewhere, 3,018,442 acres of lands were classified as to their coal character. Of this amount 2,217,579 acres were classified as noncoal land and 800,863 as coal land. Coal-land withdrawals during the year amounted to 637,274 acres, and coal-land restorations to 2,945,594 acres. The area withdrawn for classification as to coal at the close of the year was 45,935,954 acres.

The general activity in the oil industry during the year has been reflected in a measure in the classification of lands as to oil. The Survey geologists have been alert to the possibility of the existence of favorable structure in the Western States and to the association of suitable reservoirs and sources of oil with such structure. The results of their research have been reflected in the areas reserved because of their possible oil content. New withdrawals amounting to 1,001,300 acres were made during the year, and areas aggregating 154,558 acres were restored because examination determined that the lands were not favorable for the accumulation of oil. The result of the year's work, therefore, has been an increase of the area of oil reserves from 4,774,418 to 5,621,160 acres.

The classification of 1,466,471 acres of land in Colorado, Wyoming, and Utah as mineral land because they contain shales from which, it is believed, great quantities of petroleum and by-products may be distilled is a matter of much more than passing interest.

Phosphate reserves were decreased during the year. The withdrawals amounted to only 45,669 acres, while the restorations included 199,567 acres. The result was a decrease of phosphate reserves from 2,660,376 to 2,506,478 acres.

There has been marked activity recently in the designation of lands for entry in homesteads of 320 acres under the enlarged-homestead acts. During the year the Secretary, on the recommendation of the Geological Survey, designated 27,254,442 acres of land as nonirrigable under this act. At the same time the designations of 237,805 acres, which were found to have been erroneously designated, were canceled, the result being a net increase in this classification of lands of a little more than 27,000,000 acres during the year. At the end of the year 262,612,817 acres had been classified in this manner as being not susceptible of irrigation. The number of petitions received for such designation during the year was 14,913, of which 11,202 were acted upon; 7,038 were awaiting action at the end of the year.

Withdrawals for power-site purposes aggregated 150,646 acres, and restorations of lands previously withdrawn but found to be without value for power amounted to 26,099 acres. The increase of outstanding withdrawals from 2,228,105 to 2,352,652 acres was the net result of these actions.

During the year areas amounting to 11,327 acres were withdrawn as public-water reserves and 708 acres were eliminated from such reserves. The net increase in lands withdrawn as public watering places was from 182,653 to 193,272 acres.

CORRESPONDENCE.

During the year 27,468 letters were referred to the land-classification board, an increase of about 43 per cent over the preceding year. In addition, some 4,500 copies of correspondence from various bureaus were sent to the board for its information and files; this material is largely made up of copies of General Land Office letters to registers and receivers of local land offices, of reports made by agents of the General Land Office, and of copies of departmental decisions.

In the same period 16,135 letters, reports, acknowledgments, and notifications were prepared in the board. This is a decrease from last year of about 12 per cent; the total number of 16,135 includes 1,073 postal cards, less than one-fourth of the number sent out during the preceding year, and this reduction in postals accounts for the decrease in outgoing mail.

For the working days of the year these figures show a daily average of about 90 for the incoming and 53 for the outgoing mail.

The problem of so filing correspondence as to make it more accessible and convenient for reference has received careful attention, and material progress has been made in putting into effect advantageous modifications of the general filing system. Essentially, two files are now kept. One is a file of "cases," including mainly applications for entry or use of specific areas of public land, arranged by States and then serially under appropriate minor subdivisions. Cases of various types heretofore filed separately have been incorporated into the one general case file, and many bound sets have been separated into individual cases. The result of these changes, so far as they have been effected, is a material increase in convenience of use at the expense of a moderate increase in space requirements. The other file now kept in the board contains general correspondence and material that can not be reduced to cases. It is proposed to revise the subject system on which this file is based and to bring together all related correspondence, but a practicable plan of revision has not yet been adopted.

PUBLICATIONS.

A bulletin entitled "Petroleum withdrawals and restorations affecting the public domain" was prepared by M. W. Ball and Miss L. W. Stockbridge in 1914–15 and submitted for publication as Bulletin 623. This bulletin has been printed and was made available to the public in June. It gives true copies of all petroleum withdrawals and restorations, contains chapters on the purpose and history of withdrawals, oil-land law, and orders and correspondence, and is illustrated by nine State maps showing all lands included in withdrawals on January 15, 1916. Additional withdrawals and restorations have been made in some of the States since that date. These and future similar actions it is planned to make available to the public by the issue of revised reprints or appendixes to this bulletin.

COOPERATION WITH THE GENERAL LAND OFFICE.

The cooperation between the General Land Office and the Geological Survey, by which the Survey's information on the mineral and power value of lands sought under the public-land laws is made available to the department through the General Land Office, was continued during the fiscal year along the same lines as in 1914–15. The Survey received during the year 6,067 requests from the General Land Office for information as to the mineral character or the relation to water supply of public lands sought and furnished information in 6,396 cases. It also received for consideration 1,610 reports of field examinations by the General Land Office and acted on 1,461 reports of this character.

During a part of the fiscal year 1913–14 cooperation with the General Land Office was partly suspended because the staff and allotments of the board were insufficient to keep the work current. As a consequence of the suspension cases awaiting action in the Survey were nearly all disposed of by the beginning of the fiscal year 1914–15, and cooperation was resumed in part soon thereafter. At the opening of the fiscal year 1915–16 there were pending more than 2,100 cases involving the mineral character of lands. The number of mineral cases handled during the fiscal year is slightly greater than those received, so that the pending cases at the end of the year are fewer than at the beginning. The cases received involving both mineral character and water resources essentially balance the number answered, so that the pending cases of this class at the end of the fiscal year are approximately the same in number as at the beginning. The total number of cases covered by the cooperative agreement with the General Land Office pending at the end of the year is 2,065, somewhat less than the number pending at the beginning of the year. Of the pending cases 289 are concerned only with the mineral character of the land, 50 only with the water resources, and 1,726 with both mineral character and water resources.

During the year numerous applications for classification of lands included in withdrawals were received. A number of requests were sent to the Survey for the reclassification of lands as to mineral or power-site possibilities, and a large number of applications of other types were referred for consideration and report. These are considered in more detail under hydrographic and mineral classifications.

The following table shows the year's record in the several classes of cooperative cases, including those discussed above and including also requests for the designation of lands under the enlarged-homestead act and other miscellaneous cases. With the passage of the preference-right act (38 Stat., 1163) and the consequent tendency to file enlarged-homestead petitions in the local land offices instead of in the Geological Survey, work of this type has come to resemble more closely in the manner in which it is handled the other cooperative work between the two bureaus. During the year 14,913 cases of this class were received; 3,327 were pending at the beginning of the year, 11,202 were disposed of during the year, and 7,038 were awaiting action at its end.

General summary of cooperative cases, fiscal year 1915–16.

Class.	Pending July 1, 1915.	Received.	Disposed of.	Pending June 30, 1916.	Gain or loss.
Mineral character only:					
General Land Office requests for information....	180	245	335	90	+ 90
General Land Office field service reports.........	156	1,004	961	199	− 43
Applications for reclassification as to coal........	1	7	7	1	0
Applications for classification as to coal..........	4	25	15	14	− 10
Applications for classification as to phosphate....	0	19	19	0	0
Applications for classification as to oil...........	0	59	56	3	− 3
	341	1,359	1,393	307	+ 34

General summary of cooperative cases, fiscal year 1915–16—Continued.

Class.	Pending July 1, 1915.	Received.	Disposed of.	Pending June 30, 1916.	Gain or loss.
Water resources only:					
General Land Office requests for information	21	49	40	30	− 9
General Land Office field service reports	18	36	34	20	− 2
Cases in national forests	6	32	37	1	+ 5
Applications for reclassification as to water resources	11	70	69	12	− 1
Applications for rights of way	105	343	350	98	+ 7
Lists under Carey Act	1	8	8	1	0
Petitions under enlarged-homestead acts	3,327	14,913	11,202	7,038	−3,711
Desert-land proofs under irrigation projects	90	98	137	51	+ 39
	3,579	15,549	11,877	7,251	−3,672
Mineral character and water resources:					
General Land Office, requests for information	1,699	5,600	5,834	1,465	+ 234
General Land Office, field service reports	76	397	279	194	− 118
General Land Office requests for information as to water resources, accompanied by field service reports as to mineral character	81	173	187	67	+ 14
Indian Office requests for information	10	75	65	20	− 10
	1,866	6,245	6,365	1,746	+ 120
Grand total	5,786	23,075	19,560	9,301	−3,515

MINERAL CLASSIFICATION.

COAL.

Regulations.—The regulations governing the classification and valuation of coal lands approved by Secretary Fisher February 20, 1913,[1] have continued in force during the fiscal year in the same form as at the end of 1914 and 1915. The only change that has been made in the regulations since their adoption occurs in the last part of paragraph 2, which was revoked by a decision of Secretary Lane on February 16, 1915 (43 L. D., 520), the department holding that legally classification of coal land must be made by quarter quarter sections and surveyed lots and not by minor subdivisions of 2½ or 10 acres.

In the comparatively short time that these regulations have been in force they have proved the soundness of the principles underlying them. Although not materially affecting the classification and valuation of the lignite-bearing lands, as accomplished under the old procedure, the new regulations have furnished a more rational basis for the classification and valuation of the lands containing coal of higher grade. Certain modifications may become necessary as knowledge of the chemistry of coal is increased and as further statistics are collected bearing on the cost of mining and other factors affecting the value of coal lands. The regulations as they now stand furnish what is believed to be a sound and reasonable standard for the classification and valuation of land underlain by coal of any quality or thickness.

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[1] U. S. Geol. Survey Bull. 537, pp. 96, 97, 1913; Land Dec., vol. 41, pp. 528–530, 1913.

Withdrawals and restorations.—The total area of coal-land withdrawals made during the fiscal year was 637,274 acres. These withdrawals for the most part affect lands in Colorado and New Mexico which had been previously classified as coal land at the minimum price but which are now known to be much more valuable. Coal lands not hitherto known have been discovered in Utah and Montana and have been withdrawn by Executive order until detailed examination can be made. Like other recent years, the fiscal year 1915–16 has shown a substantial decrease in the area of land included in outstanding withdrawals of coal lands, because, although over 600,000 acres of land has been withdrawn during the year, a much larger area has been classified and restored. Restorations have been made as rapidly as field work and classifications have been completed, and the restorations thus effected during the year exceed the withdrawals by over 2,300,000 acres.

Coal withdrawals and restorations, fiscal year 1915–16, in acres.

State.	Withdrawals outstanding July 1, 1915.	Withdrawals, 1915–16.	Restorations, 1915–16.	Withdrawals outstanding June 30, 1916.
Arizona	118,718			118,718
California	17,643			17,643
Colorado	4,609,566	17,305	4,122	4,622,749
Idaho	338,452			338,452
Montana	12,999,115	230,301	2,097,699	11,131,717
Nevada	83,833			83,833
New Mexico	5,423,655	341,889	55,784	5,709,760
North Dakota	15,202,068		344,726	14,857,342
Oregon	26,561		22,200	4,361
Utah	5,696,616	47,779	317,665	5,426,730
Washington	847,892		637	847,255
Wyoming	2,880,155		102,761	2,777,394
	48,244,274	637,274	2,945,594	45,935,954

Classifications.—Examinations made for coal-land classification during the year have resulted in eliminating from withdrawal a large area of noncoal land in Montana and smaller areas in other States, thus continuing the policy of examining and eliminating from withdrawal as rapidly as possible areas of doubtful coal value.

During the fiscal year more than 800,000 acres have been classified as coal land and more than 2,200,000 acres as noncoal land, a total classification of 3,018,442 acres. This is considerably in advance of the results of the previous year but far below those attained annually prior to that time. The decrease in classified areas within the last two years is due partly to the elimination of the larger noncoal areas from withdrawal and the consequent restriction of field examinations to a detailed study of known coal fields and partly to a decrease in allotments for coal-land examination on account of increased demands for the examination of other mineral deposits.

In the first of the following tables the classifications made during the year are summarized by States. In the same table the classifications are divided into two groups—reclassifications, which constitute a revision of previous classifications, and new classifications, which comprise the classification of withdrawn areas or areas not previously considered. The sum of these two groups is the total classification. The net increase or decrease in total areas classified in any given State, as shown in the last two columns, is not in every case obtained directly from the other columns of the table. The figures in these two columns involve and are affected by the withdrawal of 17,305 acres in Colorado and 248,994 acres in New Mexico, previously classified as coal land, and of 76,475 acres in New Mexico and 21,439 acres in Utah, previously classified as noncoal land.

Lands classified as coal and noncoal land during fiscal year 1915–16, in acres.

State.	Total classification.			Reclassification.		New classification.		Net increase or decrease in areas classified.	
	Coal.	Noncoal.	Total.	Previous noncoal, now coal.	Previous coal, now noncoal.	Coal.	Noncoal.	Coal.	Noncoal.
Colorado	722	3,720	4,442	....	....	722	3,720	− 16,583	+ 3,720
Montana	713,478	1,426,798	2,140,276	33,844	8,733	679,634	1,413,065	+704,745	+1,392,954
New Mexico	4,164	59,979	64,143	2,359	5,000	1,805	54,979	−249,830	+ 18,855
North Dakota	74,992	269,654	344,646	....	....	74,992	269,654	+ 74,992	+ 269,654
Oregon	2,243	17,607	19,850	....	....	2,243	17,607	+ 2,243	+ 17,607
South Dakota	2,585	2,349	4,934	2,585	2,349	......	....	+ 236	− 236
Utah	279	336,274	336,553	....	80	279	336,194	+ 199	+ 314,835
Washington	......	637	637	....	....	......	637	....	+ 637
Wyoming	2,400	100,561	102,961	....	200	2,400	100,361	+ 2,200	+ 100,561
	800,863	2,217,579	3,018,442	38,788	16,362	762,075	2,201,217	+518,202	+2,080,877

Classifications of coal and noncoal land, June 30, 1916, in acres.

State.	Classification outstanding July 1, 1915.		Net result of classification, 1915–16.		Classification outstanding June 30, 1916.		
	Coal.	Noncoal.	Coal.	Noncoal.	Coal.	Noncoal.	Total.
Arizona	....	42,492	....	....	....	42,492	42,492
Arkansas	60,715	70,038	....	....	60,715	70,038	130,753
California	8,720	228,502	....	....	8,720	228,502	237,222
Colorado	3,365,147	9,246,918	− 16,583	+ 3,720	3,348,564	9,250,638	12,599,202
Idaho	2,113	7,936,925	....	....	2,113	7,936,925	7,939,038
Montana	4,855,390	20,187,282	+704,745	+1,392,954	5,560,135	21,580,236	27,140,371
Nevada	5,880	2,428	....	....	5,880	2,428	8,308
New Mexico	978,044	3,572,958	−249,830	− 18,855	728,214	3,554,103	4,282,317
North Dakota	2,099,643	2,911,671	+ 74,992	+ 269,654	2,174,635	3,181,325	5,355,960
Oregon	14,921	1,044,448	+ 2,243	+ 17,607	17,164	1,062,055	1,079,219
South Dakota	249,887	6,956,344	+ 236	− 236	250,123	6,956,108	7,206,231
Utah	1,066,464	2,919,498	+ 199	+ 314,835	1,066,663	3,234,333	4,300,996
Washington	148,940	1,561,671	....	+ 637	148,940	1,562,308	1,711,248
Wyoming	7,621,125	14,840,728	+ 2,200	+ 100,561	7,623,325	14,941,289	22,564,614
	20,476,989	71,521,903	518,202	2,080,877	20,995,191	73,602,780	94,597,971

Area and valuation of coal lands June 30, 1916.

State.	Appraised coal land July 1, 1915.	Coal land appraised, 1915-16.		Net result of appraisals, 1915-16.	Total appraised coal land outstanding June 30, 1916.	Total valuation of appraised coal land outstanding June 30, 1916.	Average value per acre.
		Total coal land appraised.	Coal land reclassified as noncoal land and rewithdrawn.				
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*		
Arkansas	60,715				60,715	$1,473,762	$24.20
California	7,720				7,720	585,066	75.70
Colorado	2,862,863	722		+ 722	2,863,585	186,158,446	65.00
Idaho	2,113				2,113	51,824	24.50
Montana	4,740,847	713,478	8,733	+704,745	5,445,592	128,849,832	23.60
Nevada	5.880				5,880	117,600	20.00
New Mexico	960,092	4,164	253,994	−249,830	710,262	16,302,834	22.90
North Dakota	2,099,643	74,992		+ 74,992	2,174,635	35,565,775	16.30
Oregon	4,672	2,243		+ 2,243	6,915	122,451	17.70
South Dakota	249,887	2,585	2,349	+ 236	250,123	2,758,587	11.00
Utah	1,048,343	279	80	+ 199	1,048,542	44,081,949	42.00
Washington	740				740	16,000	21.60
Wyoming	7,446,256	2,400	200	+ 2,200	7,448,456	385,444,847	51.70
	19,489,771	800,863	265,356	+535,507	20,025,278	801,528,993	40.00

Applications for classification and reclassification.—During the fiscal year the Survey received 25 applications for the classification of withdrawn lands either as coal or noncoal land and 7 applications for the revision of outstanding coal and noncoal classifications. Only 3 of these applications for classification of withdrawn areas were approved, 2 for coal and 1 for noncoal land; 12 were disapproved, and 14 have been held pending, most of them for detailed field examination. Eight applications relating to withdrawn areas regarding which the Survey has no detailed data were rejected because the evidence submitted by the applicants to show that the land is noncoal land was of little value and could not be made the basis of a noncoal classification. Four applications for classification as coal land were also rejected. Three requests for reclassification have been granted, one coal and two noncoal, and four rejected, one coal and three noncoal. Some of the requests for reclassification as noncoal land have related to areas of flat-lying beds where, because no coal is exposed on or near the land, claimants have been unwilling to accept the coal classification.

OIL.

Withdrawals and restorations.—The examination and withdrawal of the public lands with reference to their prospective value for deposits of petroleum and natural gas was continued during the year in California, Wyoming, Montana, North Dakota, and Louisiana. The examinations were made for the purpose of reducing the outstanding oil withdrawals in so far as the data indicated that the withdrawn lands were not valuable for oil and of adding new areas to the oil reserves wherever the data indicated the presence of oil. These examinations resulted in eliminating from withdrawal 154,558 acres of nonoil land and added to the withdrawals 1,001,300 acres of prospective oil land, a net increase of 846,742 acres for the year.

In California more than 150,000 acres in the Salinas Valley, principally in Monterey County but in part in San Luis Obispo County, was restored to entry, field examination by the Survey having shown these lands to be barren of oil. Field work in Salinas Valley also resulted in the withdrawal of a little more than 12,000 acres of land in Monterey County believed to be favorable for oil accumulation. A restoration of about 5,000 acres on the border of the reserve in San Benito County was made to permit the issuance of title in certain cases referred to the Survey from the General Land Office.

In Wyoming an area less than 500 acres in extent in Hot Springs County was restored to entry during the year, and about 211,000 acres was included in withdrawals. Approximately 60,000 acres of land on the east side of the Bighorn Basin, for the most part lying in Big Horn County but embracing also smaller areas in Washakie and Hot Springs counties, has been withdrawn on the basis of detailed field examination and office work. The discovery of oil in the fall of 1915 near the Wyoming-Montana line made it advisable to withdraw certain areas in the northern part of the Bighorn Basin previously known to the Survey but not included in an oil withdrawal. The area so withdrawn lies in Big Horn and Park counties and embraces nearly 31,000 acres. A careful consideration of information collected by the Survey during a former season's field work resulted in the withdrawal of about 120,000 acres of prospective oil land along the Rock Springs dome, in Sweetwater County, Wyo.

The keen interest manifested in the possible occurrence of oil in Montana after the discovery of oil near the Montana-Wyoming State line caused the Survey to recommend the withdrawal of all areas of favorable structure known in this part of the State, in continuance of the departmental policy of holding prospective oil lands until appropriate legislation for their disposition can be enacted. The withdrawn lands in this part of Montana may be geographically separated into two general divisions—the south-central Montana area, embracing nearly 362,000 acres in Musselshell, Meagher, Park, Sweetgrass, Stillwater, and Carbon counties, and the eastern Montana area, covering about 280,000 acres in Dawson and Custer counties.

The favorable territory extends southwestward from eastern Montana into North Dakota, and approximately 85,000 acres of land in Billings and Bowman counties in this State has accordingly been withdrawn.

In northwestern Louisiana slightly more than 52,000 acres of land has been withdrawn. This withdrawal covers vacant public lands and unsurveyed lake areas, title to which is at the present time awaiting determination.

Oil withdrawals and restorations, fiscal year 1915–16.

State.	Withdrawals outstanding July 1, 1915.	Withdrawals 1915–16.	Restorations 1915–16.	Withdrawals outstanding June 30, 1916.
Arizona	230,400			230,400
California	1,507,547	12,338	153,938	1,365,947
Colorado	87,474			87,474
Louisiana	414,720	52,310		467,030
Montana		641,622		641,622
North Dakota		84,894		84,894
Utah	1,952,326			1,952,326
Wyoming	581,951	210,236	620	791,467
	4,774,418	1,001,300	154,558	5,621,160

The lands examined and included in oil withdrawals have not definitely been classified as oil lands, and no classification of oil lands was made during the fiscal year. The lands on which oil is known or believed to be present in commercial quantities have been included in oil withdrawals pending further detailed examinations, in order to determine the mineral character of these lands and to hold the lands until legislation providing for their disposition is enacted. Lands included in oil withdrawals may therefore be considered tentatively as oil lands, although they have not been classified as such.

Of especial interest during the year was the classification of 1,466,471 acres of oil-shale land in western Colorado and adjoining areas in Utah and Wyoming. Field examination by the Survey during the seasons of 1913, 1914, and 1915 has shown that the latent potentiality of the oil shale of this region as a source of petroleum is enormous. There is also locked up in these shales a vast amount of nitrogen which can be recovered as a by-product in the refining of the shale and used in the manufacture of fertilizers, explosives, etc.

Classification of oil-shale land, June 30, 1916, in acres.

State.	County.	Area.
Colorado	Rio Blanco and Garfield	893,418
Utah	Uinta	112,959
Wyoming	Sweetwater	460,108
		1,466,471

Applications for classification.—During the fiscal year the Survey received 59 applications for classification of withdrawn oil lands as nonoil land. One of these was approved and the lands were restored to entry; 55 were disapproved for the reason that the lands were included in an outstanding oil reserve and the data on file indicate that the lands are valuable for deposits of oil. In the other 3 cases no detailed information is available to the Survey, and the data submitted by the applicants were rejected because the evidence submitted did not show that the land is nonoil land and could not be used as a basis for nonoil classification.

PHOSPHATE.

Regulations.—There has been no change in the procedure affecting classification of phosphate lands during the fiscal year. The regulations defining phosphate lands, adopted by the Survey on March 2, 1912, to guide its recommendations for the withdrawal and restoration of phosphate lands, have continued in force. Under these regulations lands underlain by deposits containing less than 30 per cent of tricalcium phosphate are considered nonmineral lands. Phosphate beds that are from 1 foot to 6 feet or more in thickness and contain 70 per cent or more of tricalcium phosphate are held to depths ranging from zero along the outcrop to the maximum of 5,000 feet in direct ratio to the variation of the thickness of the bed from 1 to 6 feet. For beds containing less than 70 per cent of tricalcium phosphate the depth limit varies from zero to the depth of a 70 per cent bed of any given thickness in direct ratio to the variation in tricalcium phosphate content from 30 to 70 per cent.

Withdrawals and restorations.—During the last year, as in previous years, every effort has been made to obtain information regarding the phosphate character of public lands in order that the nonphosphate areas might be eliminated from the phosphate reserves and newly discovered phosphate areas might be included. The total area of phosphate withdrawals made during the fiscal year amounted to 45,699 acres. The data upon which these withdrawals were based were obtained chiefly from detailed and reconnaissance examinations made by the Survey, but in part from field investigations made by mineral inspectors of the General Land Office. The withdrawal of the areas not previously known to contain phosphate was much more than balanced by the elimination of areas found not to contain phosphate, so that the net result of the season's work is a substantial decrease in the reserved areas. The outstanding withdrawals were continued so far as the data available would permit. The restorations made affected three States—Florida, Montana, and Wyoming—and amounted to nearly 200,000 acres. The net reduction of the area withdrawn therefore amounted to more than 150,000 acres.

Phosphate withdrawals and restorations, fiscal year 1915–16, in acres.

State.	Withdrawals outstanding July 1, 1915.	Withdrawals, 1915–16.	Restorations, 1915–16.	Withdrawals outstanding June 30, 1916.
Florida	120,217	40	440	119,817
Idaho	966,377			966,377
Montana	130,215		10,968	119,247
Utah	260,751	41,714		302,465
Wyoming	1,182,816	3,915	188,139	998,592
	2,660,376	45,669	199,567	2,506,478

Classifications.—Classifications as phosphate or nonphosphate land, because of the presence or absence of phosphate deposits of workable character, are expressed as withdrawals and restorations—that is, when it is determined that lands not included in a withdrawal actually contain phosphate, they are recommended for withdrawal, and when it is determined that lands included in a withdrawal do not contain phosphate they are recommended for restoration. Indian lands, however, such as those included in the Fort Hall Indian Reservation, Idaho, and in the Shoshone or Wind River Indian Reservation, Wyo., are not public lands, and therefore lands included in these reserves can not legally be withdrawn. Examinations of lands in such reservations are frequently made for the information of the Office of Indian Affairs in its administration of them. If these examinations are made for the purpose of determining whether or not the lands contain phosphate, the results are transmitted not as withdrawals or restorations but as classifications either as phosphate or nonphosphate lands.

In addition, therefore, to the classifications that are reported as withdrawals and restorations in the preceding table, direct classifications of lands in the Fort Hall Indian Reservation, Idaho, and the Wind River Indian Reservation, Wyo., have been made as indicated in the following table:

Phosphate classifications of Indian lands, fiscal year 1915–16, in acres.

State.	Phosphate land.	Nonphosphate land.
Idaho	4,080	17,440
Wyoming	20,576	85,515

Applications for classification.—During the fiscal year the Survey received 19 applications for classification of withdrawn lands as nonphosphate land. Two of these were approved and the lands restored to entry; the other 17 were disapproved because the data on file indicate that the lands are valuable for deposits of phosphate or because no detailed information is available to the Survey and the evidence submitted by the applicants was not sufficiently definite to be used as a basis for a nonphosphate classification.

POTASH.

Field work in search of commercial deposits of potash was continued by the geologic branch of the Survey during the fiscal year. The year's activities resulted in the restoration of all the withdrawn area in the Black Rock and Smoke Creek deserts, Nev., amounting to 211,384 acres. This area had been withdrawn pending the completion of tests by drilling. No new areas were withdrawn, and no changes were made in the two existing potash reserves in California or in the Columbus Marsh potash reserve in Nevada.

Potash withdrawals and restorations, fiscal year 1915–16, in acres.

State.	Withdrawals outstanding July 1, 1915.	Withdrawals, 1915–16.	Restorations, 1915–16.	Withdrawals outstanding June 30, 1916.
California	91,207	....	....	91,207
Nevada	250,806	....	211,384	39,422
	342,013	....	211,384	130,629

METALLIFEROUS LANDS.

The act of February 26, 1895 (28 Stat., 683), made provision for classifying the lands within the Northern Pacific Railroad grant in certain land districts in Montana and Idaho with respect to their mineral or nonmineral character, the work to be done by commissioners appointed for the purpose. The classifications made in many areas were unsatisfactory, and a reclassification was provided for in the sundry civil act of June 25, 1910 (36 Stat., 739). At the request of the General Land Office the work is being done by the Geological Survey. Field examination of these lands was first undertaken by the Survey during the field season of 1910. The work was continued during subsequent years and is nearing completion. Field examination of all lands thus far listed to the Survey for examination and report has been completed.

Lands in Northern Pacific Railroad grant in Idaho and Montana classified, fiscal years 1911–1916, in acres.

State.	1911	1912	1913	1914	1915	1916	Total.
Idaho:							
Mineral	45,645	19,444	1,000	....	....	....	65,789
Nonmineral	90,712	53,055	1,200	....	....	478	145,445
	136,357	72,199	2,200	....	....	478	211,234
Montana:							
Mineral	130,386	1,134	19,800	480	6,629	....	158,429
Nonmineral	21,802	83,981	65,570	7,696	7,911	2,229	189,189
	152,188	85,115	85,370	8,176	14,540	2,229	347,618
Total:							
Mineral	176,031	20,278	20,800	480	6,629	....	224,218
Nonmineral	112,514	137,036	66,770	7,696	7,911	2,707	334,634
Grand total	288,545	157,314	87,570	8,176	14,540	2,707	558,852

In addition to the above work certain lands in Custer County, S. Dak., were examined, and a report was made to the Secretary of the Interior July 7, 1915. A complete report was furnished to the Secretary of the Interior covering certain areas included in mining claims in the Grand Canyon National Monument, Ariz., examined by the Survey in April and May, 1915. Classification plats and reports of certain lands within the Fort Peck Indian Reservation previously examined by the Survey were furnished to the Commissioner of Indian Affairs and the Commissioner of the General Land Office. Certain tracts in the Molson mining district were reexamined, and a supplemental report as to the mineral character of these lands submitted to the Secretary of the Interior and the Commissioner of the General Land Office.

Metalliferous nonmineral classifications made during fiscal year 1915–16, in acres.

Montana	722,454
South Dakota	107
	722,561

HYDROGRAPHIC CLASSIFICATION.

WATER POWER.

Withdrawals and restorations.—The classification of the public lands with relation to their value in connection with water-power development was continued during the year, the withdrawals being made under the authority conferred by the two acts of June 25, 1910 (36 Stat., 847; 36 Stat., 858), and the act of August 24, 1912 (37 Stat., 497). On July 1, 1915, the area included in outstanding withdrawals was 2,228,105 acres. During the year 150,646 acres additional were withdrawn, and 26,099 acres previously included in power-site reserves were restored to the public domain. On June 30, 1916, the total area withdrawn in connection with water power was 2,352,652 acres.

Power sites withdrawn, restored to entry, and outstanding, fiscal year 1915–16, in acres.

State.	Outstanding July 1, 1915.	New withdrawals during fiscal year.	Restorations during fiscal year.	Outstanding June 30, 1916.
Alabama	120			120
Alaska	68,200	1,100		69,300
Arizona	337,431		1,640	335,791
Arkansas	17,704	4,650		22,354
California	255,690	400		256,090
Colorado	270,390	3,280		273,670
Idaho	252,973	11,532	3,760	260,745
Michigan	1,240			1,240
Minnesota	11,020	1,289		12,309
Montana	155,351	17,050	510	171,891
Nebraska	761			761
Nevada	26,311	42	200	26,153
New Mexico	13,577			13,577
Oregon	263,326	350	2,000	261,676
Utah	362,590	103,095	14,468	451,217
Washington	104,056	7,858	3,321	108,593
Wyoming	87,365		200	87,165
	2,228,105	150,646	26,099	2,352,652

Applications for reclassification.—At the beginning of the fiscal year 11 applications for the reclassification of lands included in power-site reserves were awaiting action, and during the year 70 were received. Out of this total of 81 cases action was taken on 69, leaving 12 pending at the close of the year.

Right of way applications.—Departmental regulations of January 6, 1913, under the act of Congress approved March 4, 1911 (36 Stat., 1253, 1254), and of March 1, 1913, under the act of Congress approved February 15, 1901 (31 Stat., 790), charge the Geological Survey with important administrative duties in connection with applications for rights of way over the public lands for purposes related to the development of water power. Such applications, when received in proper form at the General Land Office, are forwarded to the Survey for consideration of such matters as relative priority of applications, incompatibility of works, relative beneficial utilization of resources, and the engineering and economic features involved in the applications and permits. If the approval of an application is found to be compatible with the public interest, a draft of agreement is prepared, and a report is made to the Secretary of the Interior on the circumstances in the case. This agreement, after execution by the applicant and issuance of the permit by the Secretary of the Interior, defines the conditions under which the power is to be developed, the tenure of the site, and the provisions for the protection of the public interest as regards distribution of output, rates, and service.

In addition to applications for rights of way for hydroelectric development, a large number of applications of other types are referred to the Geological Survey for consideration and report. These embrace applications for rights of way for railroads, under the acts of March 3, 1875 (18 Stat., 482), and March 2, 1899 (30 Stat., 990), affecting public lands and Indian reservations, respectively, on which report is made as to whether or not the construction of the railroad will interfere with power or irrigation development on streams in the vicinity of the right of way; applications for rights of way for irrigation uses, under the act of March 3, 1891 (26 Stat., 1095), on which report is made as to interference with power development, the feasibility of the project, and other features; applications for rights of way across national forests for mining, milling, and municipal purposes, under the act of February 1, 1905 (33 Stat., 628); and a variety of miscellaneous applications for domestic, municipal, mining, and railroad water supply.

Applications for rights of way, fiscal year 1915–16.

Class.	Pending July 1, 1915.	Received during fiscal year.	Acted on during fiscal year.	Pending June 30, 1916.
Railroad: Acts of Congress approved Mar. 3, 1875 (18 Stat., 482), May 13, 1898 (30 Stat., 409), Mar. 2, 1899 (30 Stat., 990), etc.	29	53	54	28
Irrigation: Acts of Congress approved Mar. 3, 1891 (26 Stat., 1095), and May 11, 1898 (30 Stat., 404), etc.	29	122	127	24
Power: Acts of Congress approved Feb. 15, 1901 (31 Stat., 790), Mar. 4, 1911 (36 Stat., 1253, 1254), etc.	39	19	25	33
Miscellaneous: Acts of Congress approved Jan. 21, 1895 (28 Stat., 635), May 21, 1896 (29 Stat., 127), Jan. 13, 1897 (29 Stat., 404), May 11, 1898 (30 Stat., 404), Feb. 15, 1901 (31 Stat., 790), Feb. 1, 1905 (33 Stat., 628), Mar. 4, 1911 (36 Stat., 1253, 1254), etc.	8	149	144	13
Total number of applications for original consideration	105	343	350	98
Additional applications for reconsideration	38	79	81	36

NOTE.—The first application received from the Secretary's Office was dated October 11, 1909; from the General Land Office, November 11, 1909; from the Office of Indian Affairs, December 23, 1909.

IRRIGATION.

Reservoir withdrawals.—A number of reservoir sites, valuable principally for the storage of water for irrigation, have been examined by the Geological Survey, and, on its recommendation, the lands they include have been withdrawn from entry. The change in status of such withdrawals during the fiscal year is shown in the following table:

Reservoir sites restored to entry and outstanding, fiscal year 1915–16, in acres.

State.	Outstanding July 1, 1915.	Restorations during fiscal year.	Outstanding June 30, 1916.
Arizona	23,040	....	23,040
Montana	15,640	6,560	9,080
North Dakota	1,569	....	1,569
Oregon	10,619	....	10,619
Washington	35,943	....	35,943
	86,811	6,560	80,251

Carey Act segregations.—During the year eight proposed segregation lists under the Carey Act were received for report as to available water supply, general feasibility of plan of reclamation, and mineral character of the lands. One such list was pending report on July 1, 1915. Reports on eight of these lists had been submitted before the end of the fiscal year, and supplemental reports on eight other lists were also furnished.

Irrigation projects.—The Geological Survey, by instructions of the Secretary of the Interior, dated March 15, 1913, furnishes to the Commissioner of the General Land Office information relative to the available water supply and the feasibility of irrigation projects whose water rights or shares are presented as evidence of compliance with the requirements of the desert-land act. During the year 98 such cases were received, and 90 were carried over from the preceding year. Of these 188 cases 137 were reported on and 51 were pending June 30, 1916. Supplemental reports were rendered on 16 cases.

ENLARGED HOMESTEADS.

Classification of lands under the enlarged-homestead acts of February 19, 1909 (35 Stat., 639), June 17, 1910 (36 Stat., 531), June 13, 1912 (37 Stat., 132), March 3, 1915 (38 Stat., 953), and March 4, 1915 (38 Stat., 1163), was continued during the year. These acts are now applicable to 14 States. No additional legislation was enacted during the fiscal year. As a result of the investigations of surface and underground water conditions, designations during the fiscal year have added a large area of land to that previously classified.

Enlarged-homestead designations, fiscal year 1915–16, in acres.

State.	Outstanding July 1, 1915.	Designations during fiscal year.	Cancellations during fiscal year.	Outstanding June 30, 1916.
Arizona	25,082,017	93,338	....	25,125,355
California	1,996,598	2,878,599	....	4,875,197
Colorado	24,722,162	1,304,760	....	26,026,922
Idaho:				
Sections 1–5 only	8,455,105	1,332,397	32,893	9,754,609
Section 6	86,793	38,995	960	124,828
	8,541,898	1,371,392	33,853	9,879,437
Kansas	277,605	95,079	....	372,684
Montana	46,760,813	1,895,818	153,824	48,502,807
Nevada	46,305,197	....	....	46,305,197
New Mexico	23,374,541	2,093,491	....	25,468,032
North Dakota	8,739,507	821,203	....	9,560,710
Oregon	16,936,548	942,913	4,749	17,874,712
South Dakota	1,756,332	12,669,860	....	14,426,192
Utah:				
Sections 1–5 only	7,147,393	39,902	36,559	7,150,736
Section 6	1,219,032	55,092	....	1,274,124
	8,366,425	94,994	36,559	8,424,860
Washington	4,016,887	1,179,415	....	5,196,302
Wyoming	18,769,650	1,813,580	8,820	20,574,410
	235,596,180	27,254,442	237,805	262,612,817

The general provisions of the acts, which apply in all 14 States, permit the entry by one person of 320 acres of "nonmineral, nonirrigable, unreserved, and unappropriated surveyed public lands which do not contain merchantable timber." As a prerequisite to the allowance of such entry, the land must have been designated by the Secretary of the Interior as not being, in his opinion, "susceptible of successful irrigation at a reasonable cost from any known source of water supply." Under the provisions of section 6 of the acts of February 19, 1909, and June 17, 1910, applicable in Utah and Idaho only, the Secretary may further designate lands which do not have upon them "such a sufficient supply of water suitable for domestic purposes as would make continuous residence upon the lands possible," and entrymen upon such lands are relieved of the necessity of residence. By the act of March 3, 1915 (38 Stat., 956), the enlarged-homestead act was amended so as to permit, under certain conditions, an additional entry, though final proof had already been submitted on the original entry.

Designations under the enlarged-homestead acts are made either in large, compact areas, as a result of field investigations covering rather large districts, or in small units, as a result of investigations made at the request of prospective entrymen. These requests are referred to as enlarged-homestead petitions. The passage of the act of March 4, 1915 (38 Stat., 1163), which provides that a preference right of entry in the event of designation can be procured by filing an application at the local land office of the district in which the lands are situated has led to a very large increase in the number of applications received.

Action on petitions under the enlarged-homestead acts, fiscal year 1915–16.

State.	Pending July 1, 1915.	Received, 1915–16.	Action taken, 1915–16.					Pending June 30, 1916.	Cases reconsidered.
			All designated.	Part designated.	Refused.	Recalled.	Total.		
Arizona	13	112	12	....	....	1	13	112	....
California	162	782	298	2	17	8	325	619	15
Colorado	142	1,896	952	14	61	14	1,041	997	27
Idaho	392	1,834	931	26	175	30	1,162	1,064	106
Kansas	129	256	369	....	3	....	372	13	6
Montana	1,075	2,552	2,039	113	401	19	2,572	1,055	227
Nevada	9	36	....	....	2	....	2	43	....
New Mexico	88	1,126	213	7	30	16	266	948	16
North Dakota	23	302	234	4	7	2	247	78	6
Oregon	64	483	334	11	41	5	391	156	27
South Dakota	851	2,920	3,255	21	47	3	3,326	445	11
Utah	214	911	217	2	56	5	280	845	5
Washington	48	329	249	2	12	....	263	114	12
Wyoming	117	1,374	832	30	78	2	942	549	20
	3,327	14,913	9,935	232	930	105	11,202	7,038	478

A set of maps of the States affected, showing areas designated under the enlarged-homestead acts and the status of designations on June 30, 1916, has been printed.

PUBLIC WATER RESERVES.

As information has become available recommendations have continued to be made for the creation of public water reserves, in order that important springs and sources of stock water on the desert and semiarid range lands may remain accessible to the public. Additions amounting to 10,619 acres have been made during the year to reserves of this type.

Public water reserves withdrawn from entry and restored to entry, fiscal year 1915–16, in acres.

State.	Outstanding July 1, 1915.	Withdrawals, 1915–16.	Restorations, 1915–16.	Outstanding June 30, 1916.
Arizona	2,992	6,930		9,922
California	50,554		708	49,846
Colorado	480			480
Idaho	5,765	405		6,170
Montana	1,040			1,040
Nevada	1,464	2,872		4,336
New Mexico	1,440			1,440
Oregon	2,500			2,500
Utah	33,987			33,987
Wyoming	82,431	1,120		83,551
	182,653	11,327	708	193,272

PUBLICATION BRANCH.

DIVISION OF BOOK PUBLICATION.

SECTION OF TEXTS.

During the year 76,336 pages of manuscript were edited and prepared for printing, and proof sheets for 22,030 final printed pages were read and corrected, this work involving the handling of 5,443 galley proofs and 30,656 page proofs. The corresponding figures for 1914–15 were 48,911 pages of manuscript, 21,407 final printed pages, 5,099 galley proofs, and 35,522 page proofs. Indexes were prepared for 71 publications, covering 14,924 pages; the figures for the previous year were 66 publications and 16,723 pages. The list given on pages 18–37 shows the number, scope, and character of the reports issued during the year. A third edition of the pamphlet "Suggestions to authors of papers submitted for publication by the United States Geological Survey," by G. M. Wood, editor, was prepared and sent to press near the end of the year.

Nine persons were employed in this section.

SECTION OF ILLUSTRATIONS.

The number of illustrations prepared was 3,730, comprising 205 maps, 516 photographs prepared for reproduction, 678 diagrams and sections, 2,080 paleontologic drawings and photographs, and 251 miscellaneous illustrations. The illustrations sent to the printer were reproduced by chromolithography, 43 subjects; photolithography, 175 subjects; 4-color process, 10 subjects; mezzotint, 4 subjects; halftone engraving, 426 subjects; zinc etching, 462 subjects; wax engraving, 10 subjects; cuts already engraved, 107 subjects. Proofs to the number of 1,514, including 383 revises, were received and compared critically. The finished work representing the editions of 263 inserts furnished by contractors (mostly lithographic) was examined. Electrotypes of 44 cuts were furnished to outside applicants. At the close of the year material for illustrating 24 reports was in preparation.

As in previous years, a cost record has been maintained. The personnel of the section at the end of the year consists of the chief of the section, nine draftsmen, one under clerk, and one messenger boy.

SECTION OF DISTRIBUTION.

During the year the section of distribution received editions of 210 new books and pamphlets, 33 reprinted books and pamphlets, 6 new geologic folios, 12 new geologic maps, 137 new or revised topographic maps, 93 reprinted topographic maps, 16 new photolithographed maps, and 16 reprinted photolithographed maps, a total of 523 publications. In addition, it received many pamphlets and forms prepared for administrative use, such as index map circulars.

The total units of all publications received numbered 711,397 books and pamphlets, 20,837 folios, 3,705 geologic maps, and 927,853 topographic maps, a grand total of 1,663,792.

The section distributed 603,575 books, 23,534 folios, and 597,149 maps, a total of 1,224,258, of which 180 books, 14,717 folios, and 399,490 maps were sold.

The total amount received and turned into the Treasury as the result of sales of publications was $30,160.90. The sales of topographic and geologic maps amounted to $28,627.25, of topographic and geologic folios $1,202.10, and of books $331.55.

Eighteen persons were employed in this section during the year, and 92,831 letters were received and answered.

DIVISION OF MAP EDITING.

SECTION OF GEOLOGIC MAPS.

Nineteen folios were handled by the section of geologic maps during the year, of which six were completed and published—Nos. 196 to 201, including one folio that covers two quadrangles (Galena and Elizabeth, Ill.) and one that covers four quadrangles (Minneapolis, St. Paul, Anoka, and White Bear, Minn.).

At the close of the fiscal year the maps and illustrations of the Eureka Springs-Harrison, Ark., Colorado Springs, Colo., and Tolchester, Md., folios were completed. The maps of the Detroit, Mich., Leavenworth-Smithville, Mo.-Kans., and Deming, N. Mex., folios were printed and the illustrations were nearly completed. The maps of the Colchester-Macomb, Ill., and Newell, S. Dak., folios were partly engraved. The maps of the Elkton-Wilmington, Md.-Del., and Herman-Morris, Minn., folios were prepared for engraving and were awaiting approval of their texts. The Bessemer-Vandiver, Ala., Montevallo-Columbiana, Ala., Cleveland, Ohio, Pittsfield-Becket, Mass., and Sheffield-Sandisfield, Mass., folios were partly prepared and were awaiting revision by their authors.

In addition to the maps and illustrations of folios, the illustrations for 72 other reports were critically reviewed. The work included the revision of maps, sections, and numerous smaller text illustrations and the preparation of color schemes for the maps.

SECTION OF TOPOGRAPHIC MAPS.

At the beginning of the year 178 topographic maps were on hand for publication, and the accessions during the year were 124, making a total of 302 maps. Of these, 153 have been published, 97 are in process of engraving and printing, and 52 have not been edited. Of the 153 maps published and noticed in the list of publications on pages 37–38, 126 are new engraved maps, 16 are photolithographs, and 11 are new editions. The following statement shows the comparative status of map editing and map publication on June 30 for the last six years:

Progress of map publication for six years ended June 30, 1916.

	1911	1912	1913	1914	1915	1916
Published during the year	86	114	101	102	107	153
In process of engraving	56	65	89	69	87	97
Unedited	95	102	105	114	91	52

The manuscripts edited during the year comprise 147 maps prepared for engraving, 3 maps for photolithography, 94 sheets of plans and profiles of 19 rivers, 214 maps or sheets for the illustration of 33 Survey reports, and corrections for 142 engraved maps about to be reprinted. The proof read comprises 143 new topographic maps and corrections to 59 old maps. The index maps for 11 circulars of the series 9–323 were revised and reprinted, 12 of the State index circulars were revised and reprinted, and texts were adapted for 9 new State circulars, which also have been published.

Except that the editor of topographic maps was engaged in topographic field work for two months, six men were continuously employed in this work.

DIVISION OF ENGRAVING AND PRINTING.

TOPOGRAPHIC MAPS AND GEOLOGIC FOLIOS.

During the fiscal year 126 topographic maps were engraved and printed; 11 topographic maps were corrected after field revision and new editions printed; and 16 State maps, on a scale of 1:1,000,000, were photolithographed and printed, making the total of new maps and revised editions printed 153.

Corrections were engraved on the plates of 139 maps, of which 93 were for reprint editions. Sixteen photolithographic maps were corrected and reprinted, of which 11 were State maps on a scale of 1:500,000 and 5 were three-color topographic maps. Of the new and reprinted maps 264 different editions, amounting to 927,853 copies were printed and delivered to the map room. This is an increase of 58 editions and 221,621 copies of maps over the previous year.

Six new geologic folios were published during the year, the same number as in the preceding year. Of these, one (the Galena-Elizabeth) was a double folio, and one (the St. Paul-Minneapolis) contained four sets of geologic maps. State and octavo editions of one folio were issued during the year. Editions and partial editions amounting to 20,840 copies were printed and delivered, a decrease of 3,226 copies from the number printed in the preceding year.

OTHER GOVERNMENT MAP PRINTING.

For the Government Printing Office the following items were printed and delivered: Illustrations for the annual reports of the governor of Alaska, the governor of Hawaii, the governor of the Panama Canal, the Commissioner General of Immigration, the Commissioner of Indian Affairs, and the Superintendent of the Coast and Geodetic Survey; Department of Commerce Special Publications 18 and 33; Department of Agriculture Bulletins 234, 299, and 327; Census reports, volume 5 (Agriculture, general report and analysis); reports of the Federal Trade Commission on the fertilizer industry and on pipe-line transportation of petroleum; report of the Bureau of Education on the education of the natives of Alaska; soil surveys of Chautauqua County, N. Y., Frederick County, Va., Brazos County, Tex., Pennington County, Minn., and Polk County, Ga.; Bureau of Mines Bulletins 98 and 107; Tariff book, Washington-Alaska military cable; United States Coast Pilot, Atlantic Coast Section E, Gulf of Mexico from Key West to the Rio Grande; American Ephemeris and Nautical Almanac, 1917 and 1918; Plane-table manual (Appendix 7, report of the Superintendent of the Coast and Geodetic Survey, 1905); Interstate Commerce Commission Valuation Order No. 20; Regulations for leasing of coal lands in Alaska; Five per cent cases (Senate Doc. 466, 63d Cong., 2d sess.); Electric power development in the United States, vol. 2 (Senate Doc. 316, 64th Cong., 1st sess.); Index to report of Chief of Engineers, United States Army, from 1866 to 1912 (House Doc. 740, 63d Cong., 2d sess.); The Glacier National Park (House Doc. 1154, 63d Cong., 2d sess.); Condition of Aqueduct Bridge, Washington, D. C. (House Doc. 539, 64th Cong., 1st sess.); Report of the Alaskan Engineering Commission (House Doc. 610, 64th Cong., 1st sess.); Report of the Mississippi River Commission (House Doc. 645, 64th Cong., 1st sess.); Geological Survey Bulletins 522, 582, 606, 611, 613, 614, 619, 620, 621, 622, 623, 626, 627, 629, 630, 641, 648, 649, Professional Paper

98, Water-Supply Papers 358, 376, 377, 378, 379, 395, 398, Mineral Resources, 1914. In addition, the following separate illustrations were printed and delivered to the Government Printing Office: Diagrams of two bird reservations, two national monuments, and four reservations for use of the natives of Alaska; panoramic view of the Mesa Verde National Park; sketch map of Mount Rainier and its glaciers; map showing the origin of the scenic features of Glacier National Park; map showing glaciers of Glacier National Park; map showing route of Government railroad in Alaska; map of the United States west of Mississippi River; map of portion of Hot Springs Reservation; map of Alaska, for Bureau of Education; base map of United States, for General Land Office; outline map of United States by counties, for Department of Agriculture; map of Matanuska coal fields, Alaska; map of Bering River coal fields, Alaska; map giving general information regarding Territory of Alaska, for Department of the Interior; charts of the United States and Canada boundary lines; charts showing shad and alewife fisheries, Chesapeake Bay, 1915; Township plat, Form 4–675a; Protractor, Form 4–678, for Department of the Interior.

The following work was done for other Government departments and bureaus: For the Forest Service, maps of 30 national forests, 24 fire folders and tourist's maps, 15 proclamation diagrams of national forests, 9 enlargements of field sheets, annual program of work, allotment-estimate forms, grazing-data chart, map of southern Appalachian region, map of White Mountain region, map of national forests of Washington and Oregon showing telephone lines, and other miscellaneous work; for the General Land Office, 1,388 township plats, 600 mineral plats, 12 State maps showing homesteads, 41 plats of Colville Indian Reservation, township-plat diagram, map of Fort Berthold Indian Reservation, and other miscellaneous work; for the War Department, 50 maps of portions of Mexico; for the Navy Department, 162 hydrographic charts. Work was also done for the Department of State, Division of Militia Affairs, Interstate Commerce Commission, Bureau of Standards, Army Military Instruction Camp, Panama-Pacific International Exposition, Office of Indian Affairs, Department of the Interior, Department of Commerce, Department of Labor, District of Columbia, District Engineer, United States Army, Reclamation Service, Bureau of Insular Affairs, Coast Artillery School, Biological Survey, United States Army Signal Service, Army War College, Bureau of Lighthouses, Bureau of Foreign and Domestic Commerce, Alaskan Engineering Commission, Superintendent of National Parks, Bureau of Mines, United States and Canada Boundary Survey, Alaska Boundary Survey, Bureau of Soils, United States Military Academy, Office of Public Roads and Rural Engineering, Bureau of Plant Industry, and States Relations Service. This work for various branches of the Government amounted to about $75,000, for which the appropriation for engraving and printing geologic maps was reimbursed by transfer of credit on the books of the United States Treasury.

Work was also done for the Anthracite Bureau of Information, Wilkes-Barre, Pa.; the Edward T. Miller Co., Columbus, Ohio; the Eckert Lithographing Co., Washington, D. C.; the Redfield-Kendrick-Odell Co., New York, N. Y.; A. Hoen & Co., Baltimore, Md.; the Geological Survey of Virginia; the Georgia State College of Agriculture; and Arthur W. Gray, Milford, Del.; and the money received in payment for the work, amounting to about $540, was turned into the Treasury of the United States, to be credited to miscellaneous receipts. On requisition of the Government Printing Office, 280 transfer impressions were made and shipped to contracting printers. Under cooperative agreements, transfer impressions were furnished without charge to the State surveys of Illinois, Indiana, Kentucky, New York, and West Virginia.

There was also a large amount of miscellaneous work relating to the map publications, including index circulars, lists of geologic folios and topographic maps, and State maps.

Of contract and miscellaneous printing of all kinds, the total number of copies delivered was 3,024,143, which required 9,028,843 printings. The total number of copies printed, including topographic maps and geologic folios, was 3,972,836, requiring 14,058,326 impressions.

The sales of maps and folios, itemized on page 166, together with the $540 of miscellaneous receipts, aggregated over $30,000, so that more than one-fourth of the amount appropriated for engraving and printing the Survey maps was returned to the Treasury.

PHOTOGRAPHIC LABORATORY.

The output of the photographic laboratory consisted of 13,961 negatives, of which 3,001 were wet, 2,970 were dry, 1,598 were paper, 6,392 were field negatives developed, 826 were lantern slides, and 1,790 were made for photolithographs; 3,805 zinc plates; 400 zinc etchings; 212 celluloids; and 43,133 prints, of which 19,549 were maps and diagrams and 23,584 were photographs for illustrations. In addition, 1,830 prints were mounted and 78 lantern slides were colored.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

The work in the executive division was of the same scope as in the preceding year.

Mails, files, and records.—During the year 160,769 pieces of mail, of which 2,377 were registered, were opened and referred. In addition, 94,735 letters were received direct by the other divisions, making a total of 255,504 for the Survey, an increase of 11 per cent compared with the fiscal year 1915.

Of the letters opened in this division, 23,642 contained a total of $32,012.92 remitted for Survey publications, a decrease of less than 2 per cent in number of letters and an increase of $3,491.12 in amount compared with the fiscal year 1915.

The recording, referring, filing, and mailing of correspondence required practically the entire services of eight clerks. The number of letters mailed through the division was 185,970, an increase of 36 per cent over the preceding year. This number does not include the outgoing registered mail, which numbered 12,732 pieces, or 238,104 pieces of letter mail sent direct from other divisions. The total for the Survey was therefore 436,806, an increase of 12 per cent over 1915.

Personnel.—The roll of Secretary's appointees numbered 872 at the end of the fiscal year, 37 less than at the end of the fiscal year 1915. The total number of changes in the personnel for the year was 546, which included 107 new appointments, 144 separations, 273 promotions, 4 demotions, and 18 miscellaneous changes.

During the year 13,946 days of annual leave and 3,045 days of sick leave were granted, being only 58 per cent of the amount of annual leave and 13 per cent of the amount of sick leave which it is permissible to grant under the law; 4,722 days of leave without pay were also granted.

DIVISION OF ACCOUNTS.

A condensed statement covering the financial transactions of the fiscal year is given below, including disbursements up to September 30. The unexpended balances of that date largely represent outstanding obligations.

Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1916.[a]

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of Director	$35,340.00		$35,340.00	$35,054.44	$285.56
Salaries, scientific assistants	29,900.00		29,900.00	29,566.66	333.34
Skilled laborers, etc	20,000.00		20,000.00	19,999.82	.18
Gaging streams, etc	150,000.00	$30,694.92	180,694.92	180,468.94	225.98
Chemical and physical researches	40,000.00	.10	40,000.10	39,783.43	216.67
Preparation of illustrations	18,280.00	51.93	18,331.93	18,080.01	251.92
Mineral resources of United States	75,000.00	.75	75,000.75	74,692.03	308.72
Geologic maps of United States	110,000.00	75,128.85	185,128.85	180,946.85	4,182.00
Books for the library	2,000.00		2,000.00	1,255.09	744.91
Topographic surveys	350,000.00	2,036.11	352,036.11	350,771.87	1,264.24
Geologic surveys	350,000.00	1,888.41	351,888.41	351,007.41	881.00
Mineral resources of Alaska	100,000.00	183.38	100,183.38	98,738.19	1,445.19
Surveying national forests	75,000.00	2.40	75,002.40	74,558.67	443.73
	1,355,520.00	109,986.85	1,465,506.85	1,454,923.41	10,583.44

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[a] In addition to these appropriations amounts aggregating $215,000, for Survey publications and for rent of the building occupied by the Survey, were allotted from other appropriations but not disbursed by Survey officials.

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1916.

Appropriation.	Total.	Salaries and wages.	Transportation of persons.	Transportation of things.	Subsistence and support of persons.	Subsistence and care of animals.	Communication service.	Printing, engraving, lithographing, etc.	Advertising and publication of notices.	Furnishing heat, light, power, etc.	Special and miscellaneous service.	Materials.
Salaries, office of the Director	$35,054.44	$35,054.44										
Salaries, scientific assistants	29,566.66	29,566.66										
Skilled laborers, etc	19,999.82	19,999.82										
Gaging streams, etc	180,468.94	135,464.34	$16,942.18	$939.59	$9,249.63	$266.31	$879.12	$1,385.54		$8.40	$1,444.52	$1,975.22
Chemical and physical researches	39,783.43	27,798.95	2,382.88	2,765.53	800.10	207.72	87 70	106.79		361.61	423.43	1,226.45
Preparation of illustrations	18,080.01	16,762.91					14.65	990.49			13.00	18.56
Mineral resources of the United States	74,692.03	68,617.02	2,088.73	108.77	1,600.70		654.46	169.19			316.20	.18
Geologic maps of the United States	180,946.85	133,147.81	36.90	7.96	74.95		74.12	3,818.14		2,089.85	2,480.95	5,380.04
Books for the library	1,255.09			4.38			1.77					
Topographic surveys	350,771.87	236,160.66	27,224.43	4,471.61	44,597.75	10,147.30	1,147.33	5,057.78			1,853.36	1,789.42
Geologic surveys	351,007.41	298,444.85	16,405.83	1,153.34	13,373.58	4,480.10	723.20	4,065.41	$46.08		1,734.45	249.53
Mineral resources of Alaska	98,738.19	65,761.35	11,200.67	5,794.60	3,743.08	212.15	176.64	869.58			1,500.80	405.04
Surveying national forests	74,558.67	49,044.05	2,441.42	871.01	9,761.74	5,000.28	54.48	524.69			419.49	313.17
	1,454,923.41	1,115,822.86	78,723.04	16,116.79	83,201.53	20,313.86	3,813.47	16,987.61	46.08	2,459.86	10,186.20	11,357.61

Appropriation.	Stationery, drafting, etc., supplies.	Fuel.	Mechanic's, engineer's, etc., supplies.	Cleaning and toilet supplies.	Wearing apparel.	Forage and other supplies for animals.	Provisions.	Ammunition and explosives.	Special and miscellaneous supplies.	Equipment (including live stock).	Structures (bench marks).	Rent.
Gaging streams, etc	$1,689.89	$295.76	$333.55	$2.91	$3.25	$46.50	$92.29	$1.95	$26.34	$7,840.40	$90.00	$1,991.25
Chemical and physical researches	658.00	293.18	171.20	14.06		141.39	879.30		105.70	1,133.75		225.69
Preparation of illustrations	160.84		2.23							117.33		
Mineral resources of the United States	649.07		2.26	6.60					1.00	297.85		180.00
Geologic maps of the United States	27,187.26	89.56	690.55	158.12					13.26	5,697.38		
Books for the library	39.69									1,209.25		
Topographic surveys	1,895.44	410.45	146.72	30.60	12.50	5,524.49	185.16		228.39	6,871.66	2,854.90	162.02
Geologic surveys	1,458.46	103.83	154.27	27.57	11.35	1,168.27	2,984.94	22.85	191.70	4,197.52		10.28
Mineral resources of Alaska	1,001.93	165.51	188.15	26.78	26.25	1,223.34	2,009.35	74.25	105.41	4,280.96	5.40	10.95
Surveying national forests	345.63	85.10	13.36	24.05	1.55	2,612.57	2.20	3.36	45.21	2,963.06		12.25
	35,086.21	1,443.39	1,702.29	290.00	54.90	10,716.56	6,153.24	102.41	717.01	34,079.06	2,950.30	2,592.44

LIBRARY.

During the year the library received 10,793 books, pamphlets, and periodicals and 439 maps, a total of 11,232 publications.

It has become increasingly difficult to obtain European publications, particularly from Germany and Austria-Hungary. The files of technical and scientific serials published in those countries since the war began are much broken, and almost all the new books are lacking. With these exceptions practically all the new literature of geology has been obtained, and also a few important older publications.

Current accessions were catalogued as received and included 6,276 items. The catalogue was increased by the addition of 9,646 new cards. Systematic efforts have been made by correspondence with societies, institutions, and individuals to fill out and complete sets of serials. These efforts are bringing many valuable additions to the library.

Titles sent to the Library of Congress for printing numbered 998; letters received, 3,682; letters written, 2,984; books collated and sent to the bindery, 2,375.

The loans during the year included 6,922 books and 354 maps, a total of 7,276. This number does not include books consulted in the library by 8,198 readers.

The bibliography of North American geology for 1915 (Bulletin 645) was completed and the proof read. Work on the cumulated bibliography of North American geology has been continued, and the compiler has cooperated with the committee on geologic names in preparing tables of geologic formations. Many bibliographic lists have been prepared, and a large amount of research work has been done for members of the Survey, this work including the translation of 52 letters and papers.

The reports and maps published by the Survey during the year were promptly distributed to the exchanges of the United States, Canada, and Mexico. Foreign sendings were made four times during the year, but it has been necessary to withhold distribution to addresses in the countries at war, the international exchanges having been suspended to all these countries except Great Britain, France, and Italy.

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DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

THIRTY-EIGHTH ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30
1917

WASHINGTON
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THIRTY-EIGHTH ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

GEORGE OTIS SMITH, *Director.*

The appropriations for the work of the United States Geological Survey for the fiscal year 1916–17 comprised items amounting to $1,605,520. The plan of operations as approved by the Secretary of the Interior included geologic surveys in the United States and Alaska, reconnaissance and detailed, of 40,937 square miles, topographic surveys of 32,245 square miles, stream gaging at 1,197 stations, the classification of public lands to an amount of more than 18,000,000 acres, and the collection of statistics of production and consumption from more than 90,000 producers, covering more than 75 mineral products. During the year 203 scientific and economic reports were published, and at the end of the year the Survey members holding appointments from the Secretary numbered 934, an increase of 62.

SPECIAL FEATURES.

WAR WORK.

During the greater part of the year the activities of the Geological Survey were concentrated upon lines of investigation connected with military and industrial preparedness. This mobilization has included preparation of special reports for the use of the War and Navy departments and the Council of National Defense, the making of military surveys, the printing of military maps and hydrographic charts, and the contribution of engineer officers to the Reserve Corps.

Early in the present calendar year the Survey transmitted to the War Department a series of 28 summary reports on the underground water supplies and the soil-drainage features of the areas along the Mexican border and the Gulf and Atlantic coasts. Several State surveys cooperated with the Federal geologists in the preparation of these geologic and hydrologic reports, which were transmitted in duplicate to the War College and the Engineer Corps, for use in the selection of cantonment sites. By request of the War and Navy departments special local investigations of water-supply and drainage possibilities of reservations have been made, including the problem of supplying troops with water on the island of Oahu.

In connection with the minerals that have assumed special significance under war conditions, the work of the Geological Survey has been both expanded and made more intensive. Results already at hand as the product of years of field and office investigation have been made available in special reports published for the information of the general public or prepared for the immediate use of some official commission, committee, or bureau. Geologic field work has been concentrated on the essential mineral resources, especially those of which the domestic supply falls short of present demands. Every oil geologist available is at work in the petroleum regions where increased production can be expected to follow geologic exploration. Other geologists have been assigned to the search for commercial deposits of the "war minerals"—manganese, pyrite, platinum, chromite, tungsten, antimony, potash, and nitrate.

An increasing appreciation of the military value of the topographic surveys in progress and the desire to increase this special use of the topographic corps led in January, 1917, to the formation of the division of military surveys in the topographic branch. In March the recognition of the urgent need of military surveys resulted in the plans for field work being made to conform wholly to a program drawn up by the General Staff of the Army. This program was submitted on March 26 and by the end of June 8,192 square miles of the areas had been surveyed. These military surveys will be continued as speedily as possible with the decreasing force of topographers available for this work in the United States.

War conditions not only diverted practically all the activities of the topographic branch to the urgent needs of the War Department for military surveys but also brought about the commissioning of the majority of the technical personnel of this branch as reserve officers in the Corps of Engineers, United States Army. This created a deficiency in the force of engineers available for topographic duty, and new sources of personnel became necessary. Permission has been obtained from the Civil Service Commission to appoint topographic field assistants without status in the classified service. Such appointments began on July 2, 1917, and by the end of September 58 men were thus appointed by the Survey, of whom 20 were assigned directly to topographic parties in the field and 38 reported at Washington for observation and training as to their special fitness for the various details of duty in the field. To judge of this adaptability, the candidates have been tested by actual field work in the near vicinity of Washington, under close supervision and intensive instruction.

A report on the use of the panoramic camera in topographic surveying, already in progress, was given special military value by the addition of a chapter on the application of photogrammetry to aerial surveys. The author, Capt. J. W. Bagley, Engineer Officers' Reserve

Corps, has also served as a member of the airplane mapping committee of the National Advisory Committee for Aeronautics, his time being devoted chiefly to the perfection of a camera specially adapted to airplane use. In this work Capt. Bagley is assisted by F. H. Moffit.

A large contribution to the military service is made by the map-printing establishment of the Survey. This plant has been available for both confidential and urgent work, and during the year 96 editions of maps needed for military use have been printed for the War Department and 906 editions of charts for the Navy Department. Other lithographic work was in progress at the end of the year, some of it of a complicated character.

In some respects the largest contribution of the Survey has been the group of specially trained engineers who have been commissioned in the Engineer Officers' Reserve Corps, this group including at the end of the fiscal year 1 geologist, 7 hydrographic engineers, and 61 topographic engineers. On October 1, 1917, the number of Survey representatives holding commissions aggregated 79, of whom 37 are either already in France or have been selected for service there—7 majors, 8 captains, and 22 lieutenants. The other officers—9 majors, 10 captains, and 23 lieutenants—are in active service and, pending other orders, instructed by the War Department "to report to the Director of the Geological Survey for duty in connection with the military surveys in progress." Two of the officers in France have been appointed on Gen. Pershing's staff, Maj. Alfred H. Brooks as geologic engineer and Maj. Glenn S. Smith as topographic engineer. These appointments leave the Geological Survey without chiefs of two important divisions—the division of Alaskan mineral resources and the division of military surveys, respectively. Maj. Frank Sutton and Maj. C. H. Birdseye, who are among those ordered to France, have left the Atlantic and Rocky Mountain divisions without administrative chiefs during the war.

DEVELOPMENT OF THE MINERAL INDUSTRY.

Clarence King, the first Director of this Survey, emphasized in the administrative report of 1880 the desirableness of the Federal investigation of the mineral wealth of the country and of the industry based thereon. The advantage of this type of governmental assistance to American enterprise has never been greater or more evident than during the war period that has brought about so great an expansion of the productive capacity of mine and smelter. The large domestic industrial demands for the mineral fuels and the more important metals have been met by rapidly increased output and a larger excess made available for export. In minor minerals what had formerly been imported has been replaced by material of domestic origin. All this expansion and new development has been profitable in a national sense. America is stronger because of this larger utilization of the useful minerals.

The current geologic and statistical work of the Survey both records the results already attained and indicates the deficiency of supply not yet remedied. For a large group of "war minerals" even the several-fold increased production is not sufficient to meet the increased consumption. A speeding up has naturally followed under these conditions, but plainly the pace has not yet been reached that our natural resources and our engineering genius would seem to justify in time of emergency.

Whoever studies the mineral resources of the United States and the industries built thereon must realize that in a time of need like the present year production rather than price is the matter of prime importance; that a high price may both stimulate production and increase available reserves; that home production will result in transportation savings that are in reality a national benefit of practical value comparable with the theoretical advantage of industrial independence; and that expansion of productive capacity is possible under war conditions only as both consumer and producer can adjust their projects to the conditions that will prevail after the war, as well as to the needs of the present emergency. Illustrations of these four propositions come at once to mind.

Potash is so essential to chemical industries that a high price has been willingly paid for the small percentage thus needed, and domestic potash has come from sources that would be unproductive under more normal conditions. A potash industry to supply the other 90 per cent of our needs—mainly to fertilize the millions of acres upon which larger demands are being made for foodstuffs and cotton and tobacco—must be based upon resources or methods of recovery permitting lower costs of production.

The increase in reserves, due to higher prices and to improved mining and metallurgic practice, is shown in the case of several of the metals. Whether the margin of profit is increased by raising price or lowering costs, the beneficial tendency is to reduce the grade of ore that can be profitably utilized, and this means increasing the Nation's reserves of ore, and thus placing one industry on a more lasting foundation. This stimulating reaction of profit upon engineering efficiency is the promise of future continuance of the supply of the essential metals, such as copper and iron.

The economy of domestic production wherever possible may be shown in the present manganese situation. The Virginia miner who loads on the cars 4,500 tons of high-grade manganese ore this year is not only contributing to the steel industry that tonnage and receiving therefor compensation at the market price, but he thereby relieves the country's shipping shortage to the extent of one ship for 38 days, not including the necessary time for loading and unloading the cargo of Brazilian ore.

Finally, the proposition that present expansion of business must take into account the future is almost self-evident, although often overlooked. Opening up pyrite mines must be based upon an assured supply of ore in the ground and an assured demand for the product for a period long enough and at prices high enough to justify the development. It is not enough for the geologist to point out the ore; the acid manufacturer needs to contract both to buy the pyrite and to sell the acid. New development must rest upon a basis of something more than risk, lest expansion of productive capacity involve after-the-war losses that will swallow up war profits.

To make America industrially independent is an aim perhaps even more desirable now than three years ago and possibly also even more of a problem than was then realized.

SPECIAL PUBLICATIONS.

Among the publications of the year several deserve special mention. The entrance of the United States into the war served to increase the already large demand for information concerning the Nation's mineral resources, and a bulletin entitled "Our mineral supplies" (Bulletin 666), was prepared to meet this need. The purpose of this publication is to supplement Bulletin 599, "Our mineral reserves," published in September, 1914. A comparison of this summary of the ability of the mineral industry to meet present-day demands with the earlier and less complete review of the mineral situation serves to make plain the larger degree of national independence which has been attained in the mining, metallurgic, and chemical industries. Twenty geologists have contributed to the present bulletin, which has been published first in separate chapters, each devoted to a "war mineral" or to some mineral product important under present conditions.

Official and general demand for up to date statistics on several of the more important minerals has been met by further response by the geologists and statisticians of the Survey. The monthly statements of railroad movement of coal and coke first issued in August, 1916, were followed in June, 1917, by the compilation of weekly statements of bituminous coal and coke production, with an analysis of causes of change in rate of output. The purpose of these statistics is to serve both the Government and the trade with an authoritative index of industrial conditions.

For similar reasons the Survey began in January the issue of monthly statements of petroleum production and consumption, these statistics showing the quantity of oil moved from field sources, the quantity delivered to refiners or to consumers, and the amount in storage at the end of each month, for each of the major oil fields east of the Rocky Mountains.

At the request of the War Department a special military map of the vicinity of the Plattsburg training camp was issued in May. The survey of this area was the first purely military mapping done by the topographers of the Geological Survey and included an amount of detail never before undertaken. The area mapped was 90 square miles, with a publication scale of 3 inches to 1 mile and a contour interval of 5 feet. On the printed maps distinctions are made between barbed and smooth wire fences, stone walls, and rail fences, between the broad-leafed timber, the pine forests, and orchards, and between roads of different character, and every telegraph and telephone pole is located, as well as, of course, every building. It is believed that this map compares favorably with the best military maps issued by European countries, and this innovation in topographic work helped materially in fitting the Survey to furnish topographic engineers for service in France.

Work on another map of detailed character also contributed to the training of a large number of Survey topographers in refined, large-scale work, although made for another purpose. This is the map of Washington and vicinity, covering 464 square miles. This map is believed to be the best example in the United States of a map covering a large area of diversified topography which shows the physical characteristics of the country, as well as all the works of man. It was printed in four colors, showing automobile roads in red, and was issued in two editions aggregating 20,000 copies, of which over 15,000 copies have been sold and otherwise distributed.

NEW HOME.

The completion of the new Interior Department office building made it possible for the Survey to occupy its new home in May, 1917. This marks the culmination of the efforts of three Directors of the Survey to procure quarters both adequate for its work and safe for the Survey workers as well as the large accumulation of scientific records. In the Thirty-third Annual Report the general unfitness of the buildings occupied by the Survey was fully discussed, and the extent of the limitations on economy and efficiency thus forced upon the employees pointed out. For nearly a third of a century the privately owned building at 1330 F Street had been enlarged piecemeal as the Federal organization increased the scope and extent of its operations, until overcrowding reached the limit, whether viewed in regard to sanitation, safety, or efficiency. The new building remedies these conditions by providing 50 per cent more floor space, and all of this space that is devoted to offices, laboratories, or workrooms is well lighted.

The new building was authorized March 4, 1913, ground was broken August 16, 1915, and the building was completed about two years later. The approximate cost was $2,500,000, and, measured by floor space, it is the largest public building in Washington. The statute specified a building of modern office type, and as a public building the Interior Department office building is unique in that the requirements of use for office and laboratory purposes were given first consideration, the architectural features being determined by the size of unit decided upon as best providing for the special uses within the limitations of the appropriation.

The building occupies the whole block bounded by Eighteenth, Nineteenth, E, and F streets NW. and includes approximately half a million square feet of net floor space, accommodating the Office of the Secretary, the General Land Office, the Office of Indian Affairs, the Bureau of Mines, the National Park Service, and the Alaskan Engineering Commission, as well as the Geological Survey, which, with its library and map-printing establishment, occupies nearly one-third of the building. It is believed that this move to a new home will increase efficiency as well as avoid the danger to life and property that has been so long a matter of concern to those interested in this branch of the public service.

ARNOLD HAGUE.

Arnold Hague, one of the senior geologists of this Survey, died May 14, 1917, at the age of 76 years. He graduated at the Sheffield Scientific School of Yale University in 1863 with Clarence King, and later, as a student at Freiburg, he met S. F. Emmons, and both of them joined Clarence King early in 1867 to make the Fortieth Parallel Survey. Ten years later he made official surveys in Guatemala and the following year in China.

At the time of the organization of the United States Geological Survey in 1879 under Clarence King, Arnold Hague was appointed geologist. The results of his work have appeared in Monograph 20, on the geology of the Eureka district in Nevada, and in Monograph 32, on the Yellowstone National Park. For some years he had been engaged in a special study of geysers, and this work, his last and greatest, Mr. Hague leaves practically complete.

In addition to preparing his larger reports, Mr. Hague has contributed to scientific periodicals. He was a fellow of the Geological Society of America, of which he was president in 1910, and of the Geological Society of London, and was a member of many other scientific societies. Several universities in this country and abroad conferred upon him special degrees, but the honor he most highly appreciated was that of being made a member and officer of the National Academy of Sciences.

Mr. Hague was not a ready nor voluminous writer, but his writings were notably exact. He aimed rather to write well and truly than much. Few scientific men in America have had so wide a circle of devoted friends as Arnold Hague.

WORK OF THE YEAR.

PUBLICATIONS.

The publications of the year consisted of 1 annual report, 5 professional papers, 18 separates from 3 professional papers, 23 bulletins, 66 separates from 8 bulletins, 25 water-supply papers, 7 separates from 3 water-supply papers, 55 advance chapters from 2 annual reports on mineral resources, 5 geologic folios, 1 list of publications, 1 list of water-supply papers, 1 service bulletin, pamphlets entitled "Suggestions to authors (third edition)" and "Extracts from the Style Book of the Government Printing Office," a leaflet entitled "Nature and uses of topographic maps," advance statements on copper, lead, and zinc production in 1916, 2 circulars concerning maps and folios, 34 index map circulars, 47 press bulletins, and 12 monthly lists of new publications. The total number of pages in these publications was 17,255.

Brief notices of the publications of the year are given below:

THIRTY-SEVENTH ANNUAL REPORT OF THE DIRECTOR of the Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1916. 1916. 185 pages, 2 plates, 1 text figure.

A detailed account of the work of the Geological Survey during the fiscal year 1916, with a statement of the appropriation made by Congress for the Survey for that year. Under the heading "Special features" the Director discusses the need of economy in science, and shows how, in the several Federal bureaus especially, waste in scientific service can be avoided by cooperation. He also discusses the progress made in the search for potash in the United States, the need for a domestic supply of which has become urgent since the war has cut off the supply from the most abundant source of this material—Germany. The report contains abstracts of the books published by the Survey during the year and a list of the maps issued. The illustrations consist of maps showing areas covered by topographic and geologic surveys and a diagram showing the comparative number of maps sold by the Survey during each month of the fiscal years 1915 and 1916.

PROFESSIONAL PAPER 91. The lower Eocene floras of southeastern North America, by E. W. Berry. 481 pages, 117 plates, 16 text figures.

A comprehensive study of the lower Eocene plant remains of the southern Coastal Plain. The main body of the material examined in preparing the report came from beds embraced in the stratigraphic unit known as the Wilcox group, which comprises littoral and estuarine sediments; the remainder of the material came from strata regarded as the Midway formation, a typically marine series of deposits. Both these floras are of the greatest importance to the geologist, because they furnish the much-sought means for direct comparison between the plant-bearing formations of the Rocky Mountain province and the marine Tertiary formations of the Atlantic and Gulf waters. The plant-bearing outcrops and the various species are discussed in detail. The book also contains numerous halftone plates showing specimens of the fossil plants.

PROFESSIONAL PAPER 94. Economic geology of Gilpin County and adjacent parts of Clear Creek and Boulder counties, Colo., by E. S. Bastin and J. M. Hill. 1917. 379 pages, 23 plates, 79 text figures.

This book forms the Survey's latest contribution to the investigation of the metalliferous deposits of the Colorado ore belt. It describes the geology of the region in the vicinity of Central City, which lies nearly west of Denver, in the heart of the Front Range of the Rockies. The ores of this region yield gold, silver, copper, and tungsten in commercial quantities, and some iron. Each mine is described in detail and the treatment of the ores is discussed. The book contains numerous illustrations, including topographic and geologic maps of the Central City quadrangle, camera lucida drawings of some specimens of the ores, geologic plans of portions of the mines, and halftone plates showing features of geologic interest.

PROFESSIONAL PAPER 97. Geology and ore deposits of the Mackay region, Idaho, by J. B. Umpleby. 1917. 129 pages, 21 plates, 14 text figures.

Describes in detail the geography and geology of the Mackay region, in southeastern Idaho, north of Snake River. The existence of ore deposits in this region has been known to mining men since 1880. The principal metal recovered is copper, although silver, gold, and lead also occur in the region. It comprises eleven mining districts, all of which are treated separately in this report. At least three of these districts are of more than ordinary promise, and the author gives practical conclusions and suggestions which should aid the prospector in discovering new outcrops of ore. The illustrations consist of a geologic sketch map of the Mackay region, plans and sections of the mines, and halftone and colored plates of specimens of ore.

Parts of Professional Paper 98. Shorter contributions to general geology, 1916, as follows:

PROFESSIONAL PAPER 98–I. A reconnaissance of the Archean complex of the Granite Gorge, Grand Canyon, Ariz., by L. F. Noble and J. F. Hunter. 1916. Pp. 95–113, Pl. XIX, figs. 9–10.

Presents the results of a brief study of the Archean rocks of the Grand Canyon, especially as to their petrographic character, origin, and structure.

PROFESSIONAL PAPER 98–J. North American Upper Cretaceous corals of the genus *Micrabacia*, by L. W. Stephenson. 1916. Pp. 115–131, Pls. XX–XXIII.

Contains systematic descriptions and illustrations of some well-preserved corals of the genus *Micrabacia* from the Atlantic and Gulf Coastal Plain and from the western interior of the United States. The scarcity of specimens of corals of this genus adds to the value of these descriptions.

PROFESSIONAL PAPER 98–K. Some Paleozoic sections in Arizona and their correlation, by F. L. Ransome. 1916. Pp. 133–166, Pls. XXIV–XXXI, figs. 11–14.

Includes a brief introductory outline of the broad topographic features of Arizona, a description of the well-exposed geologic section of the Ray-Globe region, in the central part of the State, as well as of other sections, from the Grand Canyon, in the northwestern part of the State, to Bisbee, near the Mexican border, and a discussion of the correlation of these sections.

Professional Paper 98–L. The Pliocene Citronelle formation of the Gulf Coastal Plain and its flora, papers by G. C. Matson and E. W. Berry. 1916. Pp. 167–208, Pls. XXXII–XLVII, figs. 15–17.

Professional Paper 98–M. The Catahoula sandstone and its flora, papers by G. C. Matson and E. W. Berry. 1916. Pp. 209–251, Pls. XLVIII–LX, figs. 15–21.

These papers discuss briefly the general character and relations of the formations named in their titles and describe the fossil plants found in these formations, which occur in the Gulf Coastal Plain of Louisiana, Mississippi, and Alabama.

Professional Paper 98–N. Mechanics of the Panama Canal slides, by G. F. Becker. 1916. Pp. 253–261, figs. 22–24.

A geophysical study of the Panama Canal slides prepared as a contribution to the report of the committee on this subject appointed by the National Academy of Sciences. The author describes the essential features of the breaks on the Gaillard (Culebra) Cut, and discusses briefly the formation of ruptures, the bulging of the canal bottom, and the effect upon pressure of the form of the banks.

Professional Paper 98–O. Relations of the Embar and Chugwater formations in central Wyoming, by D. D. Condit. 1916. Pp. 263–270, Pls. LXI–LXIII, figs. 25–26.

In this paper the author shows that the Embar formation, which lies between the Tensleep sandstone and the Chugwater formation, comprises several distinct facies. Each of these facies is considered in detail and some of the formational boundaries in the Big Horn Mountain region are redefined. In connection with the description of the gypsum and associated strata it is suggested that conditions were possibly also favorable for accumulation of salt beds. The chance of finding such deposits down the dip below the surface is believed to be sufficient to merit further investigation.

Professional Papers 98–P, Q, R, and S. Contributions to the geology and paleontology of San Juan County, N. Mex.

These papers describe the succession of strata in a part of the San Juan Basin with the purpose of establishing a type section for the formations exposed and of bringing out their relations to the strata immediately above and below. As an aid in identifying the formations, the authors also describe the typical fauna and flora found in them. The papers are as follows:

1 (P). Stratigraphy of a part of the Chaco River valley, by C. M. Bauer. 1916. Pp. 271–278, Pls. LXIV–LXXI, fig. 27.

2 (Q). Vertebrate faunas of the Ojo Alamo, Kirtland, and Fruitland formations, by C. W. Gilmore. 1916. Pp. 279–308, Pls. LXIV, LXXII–LXXVIII, figs. 28–42.

3 (R). Nonmarine Cretaceous invertebrates of the San Juan Basin, by T. W. Stanton. 1916. Pp. 309–326, Pls. LXXIX–LXXXIII.

4 (S). Flora of the Fruitland and Kirtland formations, by F. H. Knowlton. 1916. Pp. 327–353, Pls. LXXXIV–XCI.

Professional Paper 98–T. The reef-coral fauna of Carrizo Creek, Imperial County, Cal., and its significance, by T. W. Vaughan. 1917. Pp. 355–386, Pls. XCII–CII, figs. 43–46.

A study of the fauna mentioned in the title leading to the conclusion that it is Atlantic and not Pacific in its affinities and that therefore there was interoceanic connection across Central America during upper Oligocene time. In Miocene time this connection was terminated, but the author believes that it was again established in upper Miocene or Pliocene time.

PROFESSIONAL PAPER 100-A. The coal fields of the United States: General introduction, by M. R. Campbell. 1917. Pp. 1-33, Pl. I, figs. 1-3.

The first chapter of an exhaustive report on the coal fields of the United States, to be prepared and published as rapidly as is consistent with accurate work. The object of the report is to furnish authentic information as to the quantity, quality, and geographic distribution of the coal still in the ground and available for use. Each chapter will be made up of papers treating of the coal-bearing areas of a different State, and each paper will be prepared by the geologist most familiar with the fields he describes and best acquainted with the local conditions.

Professional Paper 100-A discusses the ranks of coal and the classification of the coal areas in this country. It contains a large lithographed map of the United States showing the location of the coal fields, and so colored as to indicate the class of the coal in each field.

PROFESSIONAL PAPER 102. The inorganic constituents of marine invertebrates, By F. W. Clarke and W. C. Wheeler. 1917. 56 pages.

This paper gives the results of chemical analyses of certain fossil marine invertebrates with the object of determining just what substances each class of these organisms has contributed to the marine sediments which now form so large a part of the rocks of the earth. The organisms analyzed include Foraminifera, sponges, corals, echinoderms, Bryozoa, brachiopods, and mollusks, and the analyses show that their shells or skeletons contain silica, iron, lime, magnesia, phosphorus, and sulphur, as well as other constituents.

PROFESSIONAL PAPER 103. *Brachyceratops*, a ceratopsian dinosaur from the Two Medicine formation of Montana, with notes on associated fossil reptiles, by C. W. Gilmore. 1917. 45 pages, 4 plates, 57 text figures.

This paper gives a complete and detailed description of the skeletal anatomy of *Brachyceratops montanensis*, an extinct reptile whose fossil remains have been found in exposures of the Two Medicine formation on the Blackfeet Indian Reservation, Mont. This reptile was more than 6 feet in length and 2 feet in height and lived in late Mesozoic time. The paper is illustrated by halftone plates giving skeletal and life restorations of *Brachyceratops* and text figures picturing in detail the different parts of its bony structure.

Parts of Professional Paper 108. Shorter contributions to general geology, 1917, as follows:

PROFESSIONAL PAPER 108-A. Baked shale and slag formed by the burning of coal beds, by G. S. Rogers. 1917. Pp. 1-10, Pls. I-III.

In this paper the author discusses the causes of the burning of coal beds and its general effect on the overlying strata. The natural slags formed by this burning vary widely in mineral composition and offer a fertile field for petrologic investigation. The paper is illustrated by photomicrographs of two kinds of slag and a halftone plate showing the effects of burning coal beds in eastern Montana.

PROFESSIONAL PAPER 108-B. The Newington moraine, Maine, New Hampshire, and Massachusetts, by F. J. Katz and Arthur Keith. 1917. Pp. 11-29, Pls. IV-XII, fig. 1.

Describes a recessional moraine now represented by several segments disposed along a sinuous course of 60 miles near the Atlantic coast from Saco, Maine, to Newbury, Mass. This moraine is the result of the accumulation of glacio-fluvial detritus discharged directly into the sea, which in places has given it the form of broad, flat, delta-like plains of sand and gravel. The author concludes that the moraine belongs to the Wisconsin substage of the Pleistocene epoch.

Professional Paper 108–C. A comparison of Paleozoic sections in southern New Mexico, by N. H. Darton. 1917. Pp. 31–55, Pls. XIII–XXI, figs. 2–

Presents the broader features of the stratigraphy of southern New Mexico, with especial reference to the relations of the Paleozoic rocks. The principal formations are shown in columnar sections, and their distribution is indicated on a map of part of New Mexico and adjoining region.

Professional Paper 108–D. Wasatch fossils in so-called Fort Union beds of the Powder River basin, Wyo., and their bearing on the stratigraphy of the region, by C. H. Wegemann. 1917. Pp. 57–60, Pls. XXII–XXIII, figs. 16

Discusses the age of certain Tertiary coal-bearing rocks in the Powder River basin, a broad structural basin in northeastern Wyoming bounded on three sides by mountain uplifts. These rocks, which are the uppermost of three fresh-water formations overlying the Fox Hills sandstone, have heretofore been classified as Fort Union, but after an examination of their fossils, which this paper describes, the author shows them to be Wasatch and identifies the formation immediately below them as Fort Union.

Professional Paper 108–E. Geologic history indicated by the fossiliferous deposits of the Wilcox group (Eocene) at Meridian, Miss., by E. W. Berry. 1917. Pp. 61–72, Pls. XXIV–XXVI, figs. 17–18.

Describes two newly discovered fossil plants contained in a collection made at Meridian, Miss., in the spring of 1916. These plants form important additions to the flora of the Wilcox group, and the outcrop in which they occur furnishes new evidence of the unconformity between the lower Eocene Wilcox group and the middle Eocene Claiborne group.

Bulletin 621. Contributions to economic geology (short papers and preliminary reports), 1915, Part II, Mineral fuels; M. R. Campbell and David White geologists in charge. 1916. vii, 375 pages, 25 plates, 17 text figures, 2 inserts.

This bulletin includes 16 brief reports of two classes—(1) short papers giving comparatively detailed descriptions of occurrences that have economic interest but are not of sufficient importance to warrant a more extended description; (2) preliminary reports on economic investigations the results of which are to be published later in more detailed form. These papers are such only as have a direct economic bearing, all topics of purely scientific interest being excluded. Each paper was issued separately as an advance chapter as soon as it was ready. A list of the papers arranged according to subjects follows:

Petroleum and natural gas.

The Healdton oil field, Carter County, Okla., by C. H. Wegemann and K. C. Heald.

The Loco gas field, Stephens and Jefferson counties, Okla., by C. H. Wegemann.

The Duncan gas field, Stephens County, Okla., by C. H. Wegemann.

A reconnaissance in Palo Pinto County, Tex., with special reference to oil and gas, by C. H. Wegemann.

Possibilities of oil in the Porcupine dome, Rosebud County, Mont., by C. F. Bowen.

The Lawton oil and gas field, Okla., by C. H. Wegemann and R. W. Howell.

Anticlines in the Clinton sand near Wooster, Wayne County, Ohio, by C. A. Bonine.

A reconnaissance for oil near Quanah, Hardeman County, Tex., by C. H. Wegemann.

Oil and gas near Basin, Big Horn County, Wyo., by C. T. Lupton.

Geology and oil prospects of Cuyama Valley, Cal., by W. A. English.

Structure of the Berea oil sand in the Summerfield quadrangle, Guernsey, Noble, and Monroe counties, Ohio, by D. D. Condit.

Structure of the Berea oil sand in the Woodsfield quadrangle, Belmont, Monroe, Noble, and Guernsey counties, Ohio, by D. D. Condit.

Coal.

Field apparatus for determining ash in coal, by C. E. Lesher.

The Orofino coal field, Clearwater, Lewis, and Idaho counties, Idaho, by C. T. Lupton.

Geology and coal resources of northern Teton County, Mont., by Eugene Stebinger.

Analyses of coal samples from various parts of the United States, by M. R. Campbell and F. R. Clark.

ULLETIN 624. Useful minerals of the United States, compiled by F. C. Schrader, R. W. Stone, and Samuel Sanford. 1917. 412 pages.

A thoroughly revised edition of Bulletin 585 (published in 1914) greatly enlarged and brought up to date. Like the earlier work, the present one gives concisely the location, by States and counties, of the principal deposits of useful minerals and includes a glossary showing the composition and character of each mineral, the location of its principal deposits, and its chief uses. In the revision 160 mineral names have been added to the glossary and about 1,000 new localities of mineral deposits are listed. As a mineral directory this bulletin will be useful to scientific bureaus and educational institutions that deal with inquiries from the general public concerning commercial mineralogy, as well as to the prospector, miner, manufacturer, business man, and student of economic conditions.

BULLETIN 625. The enrichment of ore deposits, by W. H. Emmons. 1917. 530 pages, 7 plates, 29 text figures.

This paper is an amplification of an earlier Survey bulletin by the same author on the enrichment of sulphide ores (Bulletin 529). It is a discussion of representative deposits, especially of the paragenesis of their ores and of the principles that underlie the processes of enrichment. These principles are already fairly well understood and have proved to be of considerable economic value as applied to the development of many mineral deposits. The book is illustrated by halftone plates of specimens of enriched ores and diagrams, cross sections, and projections of lodes and ore bodies which exemplify the principles of enrichment.

BULLETIN 627. The lignite field of northwestern South Dakota, by D. E. Winchester, C. J. Hares, E. R. Lloyd, and E. M. Parks. 1916. 169 pages, 11 plates, 3 text figures.

This report embraces the results of geologic examinations made during the summers of 1911 and 1912 for the purpose of classifying as coal or noncoal land a large tract of public land in Perkins and Harding counties, S. Dak. This tract is a rectangular area of about 4,900 square miles and includes nearly all the valuable lignite of the State. The authors give a brief description of the geography and geology of the area as a whole and detailed descriptions of the coal beds by townships. The illustrations consist mainly of geologic maps of Harding and Perkins counties and lignite sections in these counties.

BULLETIN 630. The Chisana-White River district, Alaska, by S. R. Capps. 1916. 130 pages, 19 plates, 9 text figures.

This report deals with that part of Alaska which is drained by White and Chisana rivers and describes in detail the gold placers thus far developed in the region. The author presents evidence to show that these placers have been formed because of certain local conditions which are not likely to be repeated in other parts of the field and concludes therefore that the outlook for finding other placer deposits in this intensely glaciated region is not favorable. The evidence of wide distribution of copper and gold mineralization, however, gives promise that lode mining may be successful in this field provided it is made accessible by a railroad. The book contains topographic and geologic maps of the district, sketch maps and diagrams showing distribution of timber and geologic structure, and many halftone plates illustrating geologic features.

BULLETIN 631. The Yukon-Koyukuk region, Alaska, by H. M. Eakin. 1916. 88 pages, 10 plates, 2 text figures.

Gives the results of a reconnaissance survey in the Yukon-Koyukuk region made by the author in 1913. Although the economic results of this investigation are largely negative on account of the paucity of mineral deposits in the region, the intrusive granites to which the mineralization is due are widely distributed and thus afford some hope that auriferous deposits may still be discovered. The author presents also an analysis of the problems relating to the origin of the drainage system of the middle Yukon country.

BULLETIN 635. Spirit leveling in Georgia, 1896 to 1914, inclusive; R. B. Marshall, chief geographer. 1916. 60 pages, 1 plate.

BULLETIN 636. Spirit leveling in Arkansas, 1896 to 1915, inclusive; R. B. Marshall, chief geographer. 1916. 56 pages, 1 plate.

BULLETIN 637. Spirit leveling in Texas, 1896 to 1915, inclusive; R. B. Marshall, chief geographer. 1916. 254 pages, 1 plate.

BULLETIN 638. Spirit leveling in New Mexico, 1902 to 1915, inclusive; R. B. Marshall, chief geographer. 1916. 112 pages, 1 plate.

BULLETIN 639. Spirit leveling in Mississippi, 1901 to 1915, inclusive; R. B. Marshall, chief geographer. 1916. 80 pages, 1 plate.

Reports on precise and primary leveling in the States named, showing the exact altitude above sea level of a great many places. These elevations have been adjusted by the United States Coast and Geodetic Survey from precise leveling. The work in Texas during 1902, 1903, 1909, and 1910 was done in cooperation with the State. Each bulletin contains a halftone plate showing Geological Survey designs for bench marks.

BULLETIN 640. Contributions to economic geology (short papers and preliminary reports), 1916, Part I, Metals and nonmetals except fuels; F. L. Ransome and H. S. Gale, geologists in charge. 1917. viii, 255 pages, 9 plates, 24 text figures.

This bulletin includes 13 papers on investigations of mineral deposits except fuels in the United States in 1916. These papers are of the two classes indicated for Bulletin 621 (p. 18). Their titles, arranged according to subjects, are given on page 21.

Gold and silver.

Reconnaissance of the Conconully and Ruby mining districts, Wash., by E. L. Jones, jr.

Lode mining in the Quartzburg and Grimes Pass porphyry belt, Boise Basin, Idaho, by E. L. Jones, jr.

The Golden Arrow, Clifford, and Ellendale districts, Nye County, Nev., by H. G. Ferguson.

The Gold Log mine, Talladega County, Ala., by E. S. Bastin.

Placer deposits of the Manhattan district, Nev., by H. G. Ferguson.

Lead and zinc.

Notes on the promontory district, Utah, by B. S. Butler and V. C. Heikes.

Rare metals.

Molybdenite near Ramona, San Diego County, Cal., by F. C. Calkins.

An occurrence of nickel ore in San Diego County, Cal., by F. C. Calkins.

Tin ore in northern Lander County, Nev., by Adolph Knopf.

Tungsten deposits of northern Inyo County, Cal., by Adolph Knopf.

Miscellaneous.

Some manganese mines in Virginia and Maryland, by D. F. Hewett.

Gypsum in the southern part of the Big Horn Mountains, Wyo., by C. T. Lupton and D. D. Condit.

The Garrison and Philipsburg phosphate fields, Mont., by J. T. Pardee.

Parts of Bulletin 641, Contributions to economic geology, 1916, Part II, as follows:

BULLETIN 641–B. The oil and gas geology of the Foraker quadrangle, Osage County, Okla., by K. C. Heald. 1916. Pp. 17–47, Pls. II–III, figs. 1–10.

A brief account of the geography and geology of the Foraker quadrangle. The author describes in detail those strata which are valuable as key horizons, gives the probable positions of oil sands, portrays the geologic structure by map and stereogram, and describes fully those anticlines which he believes favorable for the accumulation of oil and gas. In conclusion he gives specific recommendations for prospecting and sets forth his reasons for believing that accumulations of oil and gas are to be found in this area.

BULLETIN 641–C. Possibilities of oil and gas in north-central Montana, by Eugene Stebinger. 1916. Pp. 49–91, Pls. IV–VII, figs. 11–12.

This paper summarizes all the available data concerning the possible occurrence of oil and gas in an area of about 22,000 square miles in north-central Montana, extending from the latitude of Great Falls northward to the international boundary, and points out a number of anticlines and other structural features in this area which seem to be favorable for prospecting. The illustrations consist of geologic sketch maps and sections showing oil and gas prospects and structural conditions.

BULLETIN 641–D. Structure of the Vicksburg-Jackson area, Miss., with special reference to oil and gas, by O. B. Hopkins. 1916. Pp. 93–120. Pl. VIII.

Describes briefly the geology of the Vicksburg-Jackson district, laying special stress on those features which indicate a possible store of oil and gas there. The author points out which of the areas that have been examined by the Survey are considered favorable and which unfavorable for the accumulation of oil. A map of the district accompanies the report.

BULLETIN 641–E. An anticlinal fold near Billings, Noble County, Okla., by A. E. Fath. 1916. Pp. 131–138, Pl. IX, fig. 1.

Discusses the possibilities of developing an oil and gas field on a certain anticline near Billings, Okla., and gives the logs of several wells that have been drilled in this vicinity.

BULLETIN 641–F. Oil shale in northwestern Colorado and adjacent areas, by D. E. Winchester. 1916. Pp. 139–198, Pls. X–XIX, figs. 13–14.

Gives the results of an examination of the Green River formation in Colorado and Utah to determine the richness of the oil shale of that formation. Contains data showing the quantity and quality of the oil that may be distilled from the richer beds of shale, the number of such beds at the different localities examined, and the general distribution of the shale throughout northwestern Colorado and adjacent parts of Utah and Wyoming.

BULLETIN 641–G. Geology of the Upper Stillwater Basin, Stillwater and Carbon counties, Mont., with special reference to coal and oil, by W. R. Calvert. 1916. Pp. 199–214, Pls. XX–XXI.

In this paper the author compares the geology of the Upper Stillwater Basin, Mont., with that of the Red Lodge district, already studied, in order to show the relation between the coal-bearing rocks of the two areas. He concludes that while the coal in the Upper Stillwater Basin compares favorably in quality with that in the Red Lodge district, the available tonnage is much less. Lack of adequate transportation facilities at present in the Upper Stillwater field also limits its production to the local demand.

BULLETIN 641–H. Geology of the Hound Creek district of the Great Falls coal field, Cascade County, Mont., by V. H. Barnett. 1916. Pp. 215–231, Pl. XXII, fig. 15.

Describes the geologic formations and structure in the Hound Creek district with reference to the occurrence or absence of coal-bearing rocks. Concludes that development of the coal deposits will depend entirely on the local demand, not only because of the poor transportation facilities of the field but also because the coal occurs in too small quantity and is too impure to justify the establishment of a plant to mine coal for shipment.

BULLETIN 641–I. Anticlines in central Wyoming, by C. J. Hares. 1916. Pp. 233–279, Pl. XXIII, figs. 16–34.

BULLETIN 641–J. Anticlines in the Blackfeet Indian Reservation, Mont., by Eugene Stebinger. 1917. Pp. 281–305, Pls. XXIV–XXV, fig. 35.

These two papers give brief accounts of the geologic formations in the districts mentioned in their titles and detailed descriptions of the anticlines and other folds that appear to contain oil or gas. The illustrations for each paper include a map showing the anticlines described in that paper. In addition, Bulletin 641–I contains geologic sections through the anticlines and Bulletin 641–J a geologic sketch map of Blackfeet Indian Reservation, showing sections and wells drilled for oil or gas.

BULLETIN 641–K. Coals in the area between Bon Air and Clifty, Tenn., by Charles Butts. 1917. Pp. 307–310, fig. 36.

This paper was prepared in order to correct a possible misunderstanding regarding the probable coal resources of a small area in Tennessee between Bon Air and Clifty. This area is represented on an economic-geology map which forms part of the Pikeville folio (Geologic Folio 21), issued by the Survey in 1894. The space was left unshaded on that map merely to express a lack of knowledge concerning the coal resources of the area, and not, as some readers have supposed, to indicate that it contains no workable coal beds. Present knowledge seems to justify the conclusion that two coal beds underlie this area, but their workable portions are so situated that investment or mining in the area should be preceded by careful and thorough prospecting.

ULLETIN 641–L. Oil resources of black shales of the eastern United States, by G. H. Ashley. 1917. Pp. 311–323.

Gives the results of distillation tests of samples of black shale from six States east of the Mississippi, especially as concern the oil content of the shales. Black shales have long been regarded as a possible source of oil, but the prohibitive cost of extracting the oil has so far prevented the process from being practical. The great demand for oil, however, created by the war, and the knowledge that the yield from the present known fields must sooner or later decline have renewed interest in oil-bearing shales and led to definite exploratory work on them.

ULLETIN 642. Mineral resources of Alaska—report on progress of investigations in 1915, by A. H. Brooks and others. 1916. 379 + x pages, 11 plates, 14 text figures.

This volume, which is made up of twelve papers by nine authors, is the twelfth of a series of annual bulletins treating of the mining industry of Alaska and summarizing the results achieved during the year in the investigation of the mineral resources of the Territory.

The arrangement and manner of treatment in this volume are the same as in those previously issued. The first paper deals with administrative matters, the second is a general summary of the mining industry, and the remainder deal more specifically with the economic geology of certain districts arranged geographically from south to north. In the geologic papers emphasis is laid on the conclusions having immediate interest to the miner. The papers were first published separately, in small editions. Their titles are given below:

Preface, by A. H. Brooks.
Administrative report, by A. H. Brooks.
The Alaskan mining industry in 1915, by A. H. Brooks.
Mining developments in southeastern Alaska, by Theodore Chapin.
Water-power investigations in southeastern Alaska, by G. H. Canfield.
Mineral resources of the upper Chitina Valley, by F. H. Moffit.
Mining on Prince William Sound, by B. L. Johnson.
The Turnagain-Knik region, by S. R. Capps.
Gold mining in the Willow Creek district, by S. R. Capps.
Preliminary report on the Tolovana district, by A. H. Brooks.
Exploration in the Cosna-Nowitna region, by H. M. Eakin.
Mineral resources of the Ruby-Kuskokwim region, by J. B. Mertie, jr., and G. L. Harrington.

BULLETIN 643. Spirit leveling in South Dakota, 1896 to 1915, inclusive; R. B. Marshall, chief geographer. 1916. 100 pages, 1 plate.

Gives the results of primary and precise leveling in South Dakota in the years mentioned, showing the altitude above sea level of more than 1,000 places. Elevations are based on heights of bench marks along precise level lines of the Coast and Geodetic Survey as adjusted in 1912, and on checked primary leveling of the Missouri River Commission. The book contains a halftone plate showing Geological Survey designs for bench marks.

Bulletin 644. Triangulation and primary traverse, 1913–1915; R. B. Marshall chief geographer. 1916. 655 pages, 2 plates.

Gives the results of triangulation and primary traverse in the United States during the years 1913, 1914, and 1915, listing 930 triangulation stations and 7,356 traverse stations, nearly all computed on North American datum. Illustrated by a map of the United States showing the condition of astronomic location and primary control to January 1, 1916, and a halftone plate showing Geological Survey bench marks. Issued first in 18 advance chapters, each covering one State or a group of adjoining States.

Bulletin 645. Bibliography of North American geology for 1915, with subject index, by J. M. Nickles. 1916. 144 pages.

A list, arranged alphabetically by authors' names, of publications on the geology of the Continent of North America and adjacent islands, also Panama and the Hawaiian Islands, issued in 1915. The book is indexed and contains lists of chemical analyses reported, and minerals, rocks, and geologic formations described.

Bulletin 646. Spirit leveling in North Carolina, 1896 to 1914, inclusive; R. B. Marshall, chief geographer. 1916. 71 pages, 1 plate.

Gives the results of primary and precise leveling in North Carolina in the years mentioned, showing the altitude above sea level of more than 800 places. Some of these elevations have been adjusted by the United States Coast and Geodetic Survey from precise leveling. The work during 1896 and from 1902 to 1910, inculsive, was done in cooperation with the State. The bulletin contains a halftone plate showing Geological Survey bench marks.

Bulletin. 648. Notes on mining districts in eastern Nevada, by J. M. Hill. 1916. 214 pages, 6 plates, 18 text figures.

The last of a series of reconnaissance reports on the geology and ore deposits of Nevada, giving special attention to the less known and comparatively undeveloped and inaccessible districts. Gives a general outline of the geology of eastern Nevada, including a brief discussion of the nature and occurrence of the ore deposits of the region, as a whole, and detailed descriptions of individual mining districts. The illustrations include a map of eastern Nevada, showing the location of some of the districts described and sketch maps of the districts themselves.

Bulletin 649. Antimony deposits of Alaska, by A. H. Brooks. 1916. 67 pages, 8 plates, 8 text figures.

A general account, so far as the known facts permit, of the stibnite lodes of Alaska, followed by more detailed descriptions of the principal antimony-bearing districts. Until recently the comparatively small consumption and low price of antimony have not encouraged the development of the Alaska stibnite deposits, although this ore, which bears the sulphide of antimony and is the principal source of the metal, has been noted in 67 localities in the Territory. The present unusual demand for antimony, however, has led to shipments of the ore from Alaska and renewed interest in the development of the Alaska mines. The illustrations consist of maps showing the distribution of antimony deposits and lodes and the location of stibnite mines and prospects.

Bulletin 650. Geographic tables and formulas (fourth edition); compiled by S. S. Gannett. 1916. 388 pages, 8 text figures.

Includes coordinates for the projection of maps on different scales, areas of quadrilaterals of the earth's surface of different extent, tables of logarithms, computations of geodetic positions, and other tables and formulas used in making maps.

ULLETIN 652. Tungsten minerals and deposits, by F. L. Hess. 1917. 85 pages, 25 plates, 4 text figures.

Gives the known general facts about tungsten, describes the minerals in which it is found and the kinds of deposits from which these minerals have been obtained, and shows, by numerous illustrations, some in the natural colors, the appearance of typical specimens of the various tungsten minerals. The paper should be of interest not only to the prospector and miner but also to those who have no particular knowledge of minerals.

ULLETIN 653. Chemical relations of the oil-field waters in San Joaquin Valley (preliminary report), by G. S. Rogers. 1917. 119 pages, 7 text figures.

A study of the chemistry of the waters of the San Joaquin Valley oil fields, based on several hundred analyses of water from different depths and leading to the following conclusions: (1) That oil-field water is not necessarily salty; (2) that sulphate diminishes in amount as the oil zone is approached and finally disappears; (3) that the concentration of carbonate increases as the oil zone is approached; and (4) that the horizon, with respect to the oil zone, at which these alterations take place is different in each field. The author first presents the evidence on which the foregoing conclusions are based and discusses the interpretation of water analyses and their value from the operator's point of view, and then discusses also the chemical relations of water and oil. He hopes that this preliminary presentation will show the importance of experimental geochemical work on the interaction of the organic constituents of oils and the inorganic substances found in the oil-field waters.

BULLETIN 657. The use of the panoramic camera in topographic surveying, with notes on the application of photogrammetry to aerial surveys, by J. W. Bagley. 1917. 88 pages, 15 plates, 22 text figures, 1 insert.

Describes the field and office instruments used in topographic surveys of certain parts of Alaska in which the ordinary plane-table instruments were supplemented by the panoramic camera, shows the way they were used, and presents some of the results obtained. The method was first tried out in Alaska because that Territory contains a greater proportion of mountains favorable for phototopographic surveying than the United States proper. Includes also a discussion, based largely on French treatises, of the use of the camera in aerial surveys. The illustrations consist of maps showing positions of camera stations, photographs taken with the panoramic camera, and diagrams showing features of the instruments and details of the computations required in using them.

BULLETIN 660–A. Notes on the geology and iron ores of the Cuyuna district, Minn., by E. C. Harder and A. W. Johnston. 1917. Pp. 1–26, Pl. I.

Part of Bulletin 660, Contributions to economic geology, 1917, Part I. A brief preliminary report of the results so far obtained in a geologic examination of the Cuyuna iron district, in connection with which a study has also been made of the rock outcrops in east-central Minnesota, immediately west, south, and east of the district. Contains a map of east-central Minnesota showing the location of the Cuyuna district and a part of the Mesabi district.

BULLETIN 661–A. The Cleveland gas field, Cuyahoga County, Ohio, with a study of rock pressure, by G. S. Rogers. 1917. Pp. 1–99, Pls. I–II, figs. 1–13.

Part of Bulletin 661, Contributions to economic geology, 1917, Part II. Describes briefly the stratigraphy, structure, and gas resources of the Cleveland field, which is of special interest on account of its immediate proximity to a great manufacturing city that has long been a consumer of large quantities of natural gas. Discusses the life and decline of gas wells in general and particularly of those in this field, which, unfortunately, is a conspicuous example of wasteful development. Contains a map showing the geologic structure of the Cleveland gas field and diagrams and curves representing the decline in rock pressure and the accompanying decrease in production in numerous wells in this field.

Parts of Bulletin 666, Our mineral supplies. This bulletin will be made up of short summaries of the mineral supplies of the United States that are useful in time of war. The following chapters have already been issued:

Bulletin 666–A. Chromite, by J. S. Diller. 1917. 5 pages.

Bulletin 666–B. Sulphur, by P. S. Smith. 1917. 4 pages.

Bulletin 666–C. Manganese, by D. F. Hewett. 1917. 12 pages, 2 text figures.

Bulletin 666–D. Platinum, by J. M. Hill. 1917. 4 pages.

Bulletin 666–E. Gypsum, by R. W. Stone. 1917. 3 pages.

Bulletin 666–F. Salt, bromine, and calcium chloride, by R. W. Stone. 1917. 4 pages.

Bulletin 666–G. Sand and gravel, by R. W. Stone. 1917. 3 pages.

Bulletin 666–H. Asbestos, by J. S. Diller. 1917. 4 pages.

Bulletin 666–I. Talc and soapstone, by J. S. Diller. 1917. 2 pages.

Bulletin 666–J. Phosphate rock, by R. W. Stone. 1917. 4 pages.

Bulletin 666–K. Grinding and polishing materials, by F. J. Katz. 1917. 3 pages.

Bulletin 666–L. Graphite, by H. G. Ferguson. 1917. 7 pages.

Bulletin 666–M. Coal, by C. E. Lesher. 1917. 7 pages.

Bulletin 666–N. Potash, by H. S. Gale. 1917. 4 pages.

Bulletin 666–O. Bauxite and aluminum, by J. M. Hill. 1917. 4 pages.

Bulletin 666–P. Alaska's mineral supplies, by A. H. Brooks. 1917. 14 pages.

Bulletin 666–T. Clay and clay products, by Jefferson Middleton. 1917. 3 pages.

Bulletin 666–W. Barium and strontium, by J. M. Hill. 1917. 3 pages.

Water-Supply Paper 360. Surface water supply of the United States, 1913, Part X, The Great Basin; N. C. Grover, chief hydraulic engineer; E. A. Porter, H. D. McGlashan, F. F. Henshaw, and G. C. Baldwin, district engineers. 1916. 293 pages, 2 plates, 1 text figure.

Water-Supply Paper 361. Surface water supply of the United States, 1913, Part XI, Pacific slope basins in California; N. C. Grover, chief hydraulic engineer; H. D. McGlashan and F. F. Henshaw, district engineers. 1916. 514 pages, 2 plates, 1 text figure.

Water-Supply Paper 362. Surface water supply of the United States, 1913, Part XII, North Pacific drainage basins; N. C. Grover, chief hydraulic engineer; G. L. Parker, W. A. Lamb, G. C. Baldwin, and F. F. Henshaw, district engineers. 1916. 764 pages, 2 plates. (Issued first in three separate chapters bearing the following titles: A, Pacific basins in Washington and Upper Columbia River basin; B, Snake River basin; C, Lower Columbia River and Rogue, Umpqua, and Siletz rivers.)

These reports present briefly the results of measurements of stream flow made in the drainage basins named during the calendar year 1913. Data for each gaging station are given under the following headings: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Winter flow, Diversions, Accuracy, and Cooperation. The books contain also tables giving gage heights and daily and monthly discharges at each station, and halftone plates representing typical gaging stations, current meters, and automatic water-stage recorders.

ATER-SUPPLY PAPER 380. The Navajo country, a geographic and hydrographic reconnaissance of parts of Arizona, New Mexico, and Utah, by H. E. Gregory. 1916. 219 pages, 29 plates, 29 text figures.

Gives a brief account of the history and exploration of the Navajo country, a description of its geographic features, and a detailed discussion of its water resources. The Navajo country includes six Indian reservations, comprising more than 22,000 square miles—the largest area of undeveloped Indian land in the United States. As the future of this region depends fundamentally on its water supply, the author, in his investigations, devoted his efforts primarily to the solution of this problem. The illustrations include topographic and geologic maps of the Navajo country, numerous halftone plates depicting interesting features of its geography and geology, sections of many of the wells in the region, and diagrams showing distribution of ground water and rainfall and methods of constructing wells and water catches.

WATER-SUPPLY PAPER 381. Surface water supply of the United States, 1914. Part I, North American slope drainage basins; N. C. Grover, chief hydraulic engineer; C. C. Covert, C. H. Pierce, and G. C. Stevens, district engineers. 1916. 195+xxxvii pages, 2 plates.

WATER-SUPPLY PAPER 382. Surface water supply of the United States, 1914. Part II, South Atlantic and eastern Gulf of Mexico basins; N. C. Grover, chief hydraulic engineer; G. C. Stevens and W. E. Hall, district engineers. 1916. 66+xxx pages, 2 plates.

WATER-SUPPLY PAPER 384. Surface water supply of the United States, 1914. Part IV, St. Lawrence River basin, prepared under the direction of N. C. Grover, chief hydraulic engineer, by W. G. Hoyt, A. H. Horton, C. C. Covert, and C. H. Pierce. 1916. 128+xxix pages, 2 plates.

WATER-SUPPLY PAPER 386. Surface water supply of the United States, 1914. Part VI, Missouri River basin; N. C. Grover, chief hydraulic engineer; W. A. Lamb and Robert Follansbee, district engineers. 1917. 220+xli pages, 3 plates.

WATER-SUPPLY PAPER 387. Surface water supply of the United States, 1914. Part VII, Lower Mississippi River basin; N. C. Grover, chief hydraulic engineer; Robert Follansbee and G. A. Gray, district engineers. 1916. 60+xxxiv pages, 2 plates.

WATER-SUPPLY PAPER 391. Surface water supply of the United States, 1914. Part XI, Pacific slope basins in California; N. C. Grover, chief hydraulic engineer; H. D. McGlashan and F. F. Henshaw, district engineers. 1917. 334+xxxvi pages, 2 plates.

WATER-SUPPLY PAPER 392. Surface water supply of the United States, 1914, Part XII, North Pacific drainage basins, A: Pacific drainage basins in Washington and upper Columbia River basin; N. C. Grover, chief hydraulic engineer; G. L. Parker and W. A. Lamb, district engineers. 1916. 200 pages, 2 plates.

WATER-SUPPLY PAPER 393. Surface water supply of the United States, 1914, Part XII, North Pacific drainage basins, B: Snake River basin; N. C. Grover, chief hydraulic engineer; G. C. Baldwin and F. F. Henshaw, district engineers. 1916. 248 pages, 2 plates.

WATER-SUPPLY PAPER 394. Surface water supply of the United States, 1914, Part XII, North Pacific drainage basins, C: Lower Columbia River and Pacific drainage basins in Oregon; N. C. Grover, chief hydraulic engineer; F. F. Henshaw and G. L. Parker, district engineers. 1917. 180+xlix pages, 2 plates.

These papers present briefly the results of measurements of stream flow in the basins named in the titles during the calendar year 1914. Data for each gaging station are given under the following heads: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Extremes of discharge, Diversions, Accuracy, and Cooperation. The books contain also tables giving gage heights and daily and monthly discharges at each station and halftone plates representing typical gaging stations, current meters and automatic water-stage recorders. At the end of each book (except Nos. 392 and 393, which must be combined with No. 394 to make the complete report for the year on the north Pacific basins) is a list of all gaging stations maintained in the drainage basins covered and an annotated list of publications issued by the United States Geological Survey relating specifically to the region, as well as a similar list of reports that are of general interest, covering a wide range of hydrologic subjects, and brief references to reports published by State and other organizations.

Water-Supply Paper 395. Colorado River and its utilization, by E. C. La Rue. 1916. 231 pages, 25 plates, 5 text figures.

This paper assembles the principal facts relating to the water resources of Colorado River, on the proper control of which depends the productivity and prosperity of an area extending over parts of seven States. The author has studied especially the possibility of controlling the flow of the whole river by means of storage reservoirs, so as to avoid a recurrence of the disastrous effects on Imperial Valley caused a few years ago by the diversion of the whole flow of the river instead of merely a part to the Salton Sink. Proper control would also render available for profitable use an enormous quantity of water which now flows unused and almost unusable to the Gulf of California in the form of floods.

The illustrations consist of maps showing irrigable land in parts of the Colorado River basin and diversions from this basin to that of Mississippi River and to the Great Basin, charts showing daily and annual discharge and gage heights of Colorado River, and photographic reproductions of scenes along the river.

Water-Supply Paper 396. Profile surveys in the Colorado River basin in Wyoming, Utah, Colorado, and New Mexico, prepared under the direction of W. H. Herron, acting chief hydrographer. 1917. 6 pages, 43 plates.

Consists chiefly of maps showing outlines of river banks, islands, position of rapids, falls, and shoals, and existing dams in the Colorado River basin. The streams to which the surveys relate are fully described in Water-Supply Paper 395.

Parts of Water-Supply Paper 400, Contributions to the hydrology of the United States, 1916, as follows:

Water-Supply Paper 400–B. Artesian water for irrigation in Little Bitterroot Valley, Mont., by O. E. Meinzer. 1916. Pp. 9–37, Pls. I–IV, figs. 1–4.

Discusses the water resources of the semiarid Little Bitterroot Valley, in northwestern Montana, which was opened to white settlers in 1910. Little Bitterroot River, which traverses the valley, does not furnish enough water to irrigate the farms, and the rainfall is also inadequate. The author recommends the use for irrigation of artesian water, the supply of which is very plentiful in the valley now, and he advocates project ownership rather than private, so that there may be no waste.

Water-Supply Paper 400–C. The measurement of silt-laden streams, by R. C. Pierce. 1916. Pp. 39–51, figs. 5–6.

Gives the results of discharge measurements of San Juan River made near Bluff, Utah, during the summer of 1915, together with diagrams showing the rating, area, and velocity curves of the stream flow. The paper should be of interest to hydraulic engineers who may have occasion to measure streams carrying heavy loads of silt.

ater-Supply Paper 400–D. Accuracy of stream-flow data, by N. C. Grover and J. C. Hoyt. 1916. Pp. 53–59.

A discussion of the conditions affecting accuracy of records of daily discharge and of the degree of accuracy required in such records for their three principal uses—in predicting flow, in the immediate operation of hydraulic works, and in studying past flow.

Vater-Supply Paper 400–E. Ground water for irrigation in the Morgan Hill area, Cal., by W. O. Clark. 1917. Pp. 61–108, Pls. V–VII, figs. 7–11.

Describes briefly the geology and drainage of the Morgan Hill area, Cal., a part of Santa Clara Valley about 20 miles from the city of San Jose, with especial reference to its ground-water supply and the best means of utilizing it. Contains maps of the area showing positions and fluctuations of the water table at different stages, logs of wells, and tables giving water levels in many of the wells.

ater-Supply Paper 402. Surface water supply of the United States, 1915. Part II, South Atlantic and eastern Gulf of Mexico basins; N. C. Grover, chief hydraulic engineer; G. C. Stevens and W. E. Hall, district engineers. 1916. 51 + xxx pages, 2 plates.

ater-Supply Paper 405. Surface water supply of the United States. 1915. Part V, Hudson Bay and Upper Mississippi River basins; N. C. Grover, chief hydraulic engineer; W. G. Hoyt and A. H. Horton, district engineers. 1917. 215 + xxx pages, 4 plates.

ater-Supply Paper 407. Surface water supply of the United States, 1915, Part VII, Lower Mississippi River basin; N. C. Grover, chief hydraulic engineer; Robert Follansbee and G. A. Gray, district engineers. 1917. 43 + xxxiii pages, 2 plates.

These reports present briefly the results of measurements of stream flow made in the drainage basins named during the calendar year 1915. They are similar to the reports for 1914 noticed on pages 27–28.

Vater-Supply Paper 415. Surface waters of Massachusetts, by C. H. Pierce and H. J. Dean, 1916. 433 pages, 12 plates, 6 text figures.

A compilation of available data on the flow of Massachusetts streams, including the classic records collected on the Merrimack at Lowell and Lawrence, on the Connecticut at Holyoke, and on the Cochituate and Sudbury by the Metropolitan Water and Sewerage Board, as well as records covering shorter periods, all of which have been studied in the light of the best obtainable information and revised where necessary and possible. Contains also a gazetteer of streams, lakes, and ponds in Massachusetts and illustrations, consisting of a map of the State showing the principal drainage basins and location of gaging stations, a profile of Deerfield River, curves showing the water-stage record of several of the streams, and views of dams and other devices employed to utilize their water power.

Water-Supply Paper 416. The divining rod, a history of water witching, with a bibliography, by A. J. Ellis. 1917. 59 pages, 4 text figures.

This paper was published as a reply to the numerous inquiries that are continually received by the Survey from all parts of the country as to the efficacy of the divining rod in locating underground water. The use of a forked twig, or so-called divining rod, in locating minerals is a curious superstition that has been a subject of discussion since the middle of the sixteenth century and still has a strong hold in the popular mind. Needless to

Inez, Ky.
Interlachen, Fla.
Iowa (State).[1]
Jacinto, Cal.
Jacobs Corner, Cal.
Kiefer, Okla.
Kilmarnock, Va.
Kimmswick, Mo.-Ill.[2]
Kurand, Cal.[3]
Liberty, Maine.
Logan, Utah-Idaho.
Logandale, Cal.
Lyman, Cal.
Malone, N. Y.
Mathews, Va.
Mechanicsburg, Ohio.
Merced, Cal.
Milford Center, Ohio.
Minnesota (State).[1]
Mississippi (State).[1]
Missouri (State).[1]
Mitchell School, Cal.
Morrow, Ohio.
Muscle Shoals, Ala.
Nashua, Mont.
Octa, Ohio.
Pikeville, Ky.
Plattsburg training camp, N. Y.
Point of Sands, N. Mex.
Portland and vicinity, Maine.
Portnèuf, Idaho.
Pounding Mill, Va.-W. Va.[3]
Priest Rapids, Wash.
Richlands, Va.[3]
Riverbank, Cal.
Rogersville, Ala.
Sabina, Ohio.
St. Charles, Mich.
San Juan Bautista, Cal.
Santa Rosa, Cal.
Sturgeon, Mo.
Talking Rock, Ga.
Three River, Mich.-Ind.
Tomah, Wis.
Tularosa, N. Mex.
Turlock, Cal.
Urbanna, Va.
Vernal, Utah.
Washington and vicinit D. C.-Md.-Va.
Washington (national capital
Waterford, Cal.
White Mountain, Cal.-Nev.
Willamette Valley, Ore sheet 7.[4]
Willamette Valley, Ore sheet 8.[4]
Wind Gap, Pa.
Xenia, Ohio.

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[1] Photolithograph, 1 : 1,000,000.
[2] Sheet completed; part engraved in 1913.
[3] Preliminary edition, showing part of quadrangle.
[4] Photolithograph in colors.

GEOLOGIC BRANCH.

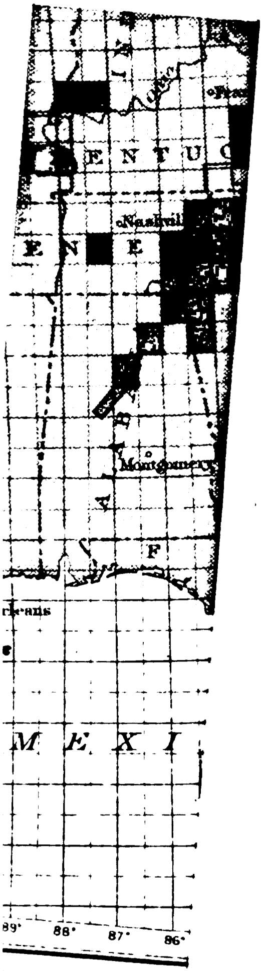
SCOPE OF WORK.

The Survey was established for "the classification of the publi lands and the examination of the geological structure, mineral resources, and products of the national domain" and was later authorized "to continue the preparation of a geological map of th United States." The operations of the geologic branch extend t every region of the country and to nearly every field of geology. I has taken the lead both in scientific geologic research and in assistin the development of the mineral resources of the country, as well a taking a part in both popular and technical geologic education. As national bureau of public information on geologic matters, relatin to not only all parts of the United States and Alaska but to othe countries as well, the Survey's activities are shown by the range o its correspondence, which is constantly increasing.

ORGANIZATION.

The geologic branch is organized in four divisions—geology, Davi White, chief geologist, in charge; Alaskan mineral resources, Alfre H. Brooks, geologist, in charge; mineral resources, H. D. McCaskey geologist, in charge; and chemical and physical researches, G. F Becker, geologist, in charge.

The geologic investigations to be carried on by the Survey in th United States are planned by the chiefs of sections in the division o geology in council with the chief geologist. The chief geologist als gives particular attention to cooperation with State surveys and devotes such time as is available to him for field work to field inspections and conferences with chiefs of sections and geologists and to th direction and inspection of the work of the section of oil and ga investigations.



Ohio
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86°

BLISHED

PUBLICATIONS.

The publications of the fiscal year 1917 prepared wholly or partly n the geologic branch embrace 36 professional papers, bulletins, etc., 05 chapters of reports later published as annual volumes, and 5 geologic folios. Titles and brief abstracts of these publications are given on pages 14–31. Besides the official publications, 44 papers were, with the permission of the Director, published by scientific societies r elsewhere in scientific and technical journals. Seven reports based n work done in cooperation with State geological surveys have, in ccordance with the cooperative agreements, been transmitted to the States for publication. One extensive report, prepared in cooperation with the Carnegie Institution, the Bureau of Fisheries, and the Panama Canal Commission, has been submitted to the National Museum for publication. In the preparation of the reports of mineral production considerable material relating to certain of the industries in the different States is compiled by the State geologists.

PROGRESS OF GEOLOGIC MAPPING.

The areas in the United States covered by geologic maps published by the Survey and the general nature of the work in each area are shown on Plate I. This map does not, however, indicate areas for which reports, prepared by this Survey, have been submitted for publication to cooperating State organizations or to other bureaus and departments of the Federal Government.

The progress of geologic surveying in Alaska is described in the section on the devision of Alaska mineral resources (pp. 81–91).

DIVISION OF GEOLOGY.

ORGANIZATION AND PERSONNEL.

The scientific force of the division of geology at the beginning of the year consisted of 72 geologists, 29 associate geologists, 31 assistant geologists, 7 junior geologists, and 17 geologic aids. During the year 14 members of the scientific staff resigned to take positions in private life at higher salaries; 3 members died; 2 were transferred to another bureau; 1 was transferred to the land-classification board; 12 were dropped from the rolls; 9 new members were appointed; and 1 was transferred from another division. The total number of geologists of various grades on the divisional staff at the end of the year was 134, there having been a net loss of 22.

For most of the year the division of geology included 10 sections, the scope of whose work was outlined in the last report. In April, on account of the increasing importance of the metals used in steel making and the special attention required for the alloy metals on account of war conditions, a redistribution of the work among 11 sections was made, as stated on pages 43–46.

The geologic work of the division, both in the field and in the office, is under the immediate supervision of the chiefs of the respective sections, who are directly responsible for efficiency in operation and the scientific standard of results. Exceptions have been made of the studies of the structure in the Great Basin region by G. K. Gilbert and of the petrologic, structural, and historical researches in the San Juan region of Colorado by Whitman Cross. The work of these distinguished senior geologists of the Survey is reported directly to the chief geologist. The general monographic treatment of the geology of the Yellowstone National Park, long in preparation by Arnold Hague, was nearly completed at the time of his death early in May.

R. V. L. Stratton, of the geologic branch, received a commission as lieutenant (assistant paymaster) in the United States Navy prior to June 30, 1917.

ALLOTMENTS.

The total funds available for the geologic work of the Survey in the United States for the year 1916–17 were as follows:

Geologic surveys	$350,000
Statutory salaries	13,700
Search for potash deposits (part of the appropriation for chemical and physical researches)	16,700
	380,400

These funds were allotted as follows:

Section of eastern areal geology	$18,700
Section of western areal geology	29,820
Section of Coastal Plain investigations	14,810
Section of stratigraphy and paleontology	18,120
Section of metalliferous deposits	54,600
Section of nonmetalliferous deposits (including potash)	38,820
Section of glacial geology	6,150
Section of eastern coals	7,040
Section of western coals	18,510
Section of iron and steel alloys[1]	600
Section of oil and gas	52,380
Geologic map editing	7,020
Great Basin investigation and inspection	3,600
Supervision, administration, salaries of clerical, technical, and skilled labor forces, instruments, supplies, and contingent fund	80,510
	350,680
Land-classification board	29,720
	380,400

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[1] The work of this section during the spring was mainly carried in the allotments of other sections.

Of the amounts allotted to this division $272,500 was expended directly for field work, including the search for potash. Of this amount $180,800, or 66.3 per cent, was expended west of the one hundredth meridian and $91,700, or 33.7 per cent, east of the one hundredth meridian. With the $29,720 for the operations of the land classification board, 69.6 per cent of the total, exclusive of the allotment for supervision, etc., was spent for investigations west of the one hundredth meridian—that is, essentially in the public land States. The expenditures for supervision, etc., are divisible in about the same proportion between the eastern and western work.

COOPERATION WITH FEDERAL BUREAUS AND STATE SURVEYS.

In strictly geologic field investigations or paleontologic studies the Survey cooperated, through the division of geology, with 25 States—Alabama, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Mississippi, Missouri, New Jersey, North Carolina, North Dakota, Oklahoma, Ohio, Pennsylvania, Tennessee, Texas, Vermont, Virginia, Washington, and Wisconsin. Informal cooperation exists between the Survey and all the States having geological surveys.

Foremost in the service rendered by the geologic branch of the Survey to other departments are the reports on the drainage and underground water supplies of the Gulf and Atlantic Coastal Plain and the information furnished as to camp locations, foundations, building materials, etc. The Survey cooperated with the Bureau of Mines in the metallographic study of ores and the investigation of the invasion of California oil wells by salt water, and with the Bureau of Mines, the Bureau of Standards, and the Office of the Supervising Architect in the grading of the Indiana limestones. A technologic paper prepared by a Survey geologist in the course of his detailed investigations of mineral deposits has been submitted for publication to the Bureau of Mines, which in turn has transmitted to the Survey a geologic report to be published as a bulletin. The Survey is also engaged with the Bureau of Standards, the Bureau of Mines, and the Office of Public Roads and Rural Engineering in a thorough and systematic study of the building stones of the United States. Field examinations of oil, gas, and nitrate deposits have been made for the War and Navy departments. Through the division of geology it cooperated informally with the Smithsonian Institution, the Bureau of Fisheries, the Coast and Geodetic Survey, the Forest Service, the Weather Bureau, the Lighthouse Service, and the Office of Indian Affairs, as well as with a number of institutions of learning, including in particular the Geophysical Laboratory and the Marine Biological Station of the Carnegie Institution. Services have been rendered to the Department of Justice in connection with its suits regarding public lands; to the Bureau of Foreign and Domestic Commerce in reporting the production of certain raw materials; and, most important of all, to the General Land Office in the classification of withdrawn coal, oil, and phosphate lands.

GENERAL FEATURES OF THE WORK OF THE YEAR.

All phases of geologic work have been continued, though for lack of funds it has been necessary to refuse requests for field examinations in greater number than ever before. During the later part of the year, especially after the declaration of war, not only were such requests much more numerous but the offers to the Government of mineral deposits of many kinds and in many regions necessitated special examination of all available data.

The dominant feature of the work of this division during the year has been the greater concentration of effort along economic lines, particularly in the location and development of mineral deposits of special importance to the successful prosecution of the war and the continued maintenance of the industrial strength of the Nation.

In recognition of the probable deficiency of the domestic petroleum supply to meet the demands to be made upon it for war purposes, this vital question was among the first to receive attention. Careful estimates of the country's oil resources, based on the most complete and trustworthy criteria available, were made by the oil and gas geologists most familiar with the different fields and provinces. The general results of these estimates, summarized by fields and integrated as to oil contents of the public lands, naval reserves, etc., have been published. At the same time the progress of exploration by the drill has been carefully followed, and every effort has been made to extend assistance. The search for areas in which the geologic conditions, including the structure, would appear to be favorable for the occurrence of undiscovered oil pools was pushed as vigorously as was possible with the available resources in funds and trained oil and gas geologists. Mention of this work will be found in the accounts of the geologic investigations in the different States. During the year ten reports pointing out areas favorable for testing in different State have been printed; nine similar reports are in process of publication, and fifteen others are in process of criticism or ready for transmission. For some areas, in order to bring more quickly the particular results of the geologic explorations to the attention of the public, short advance statements have been distributed to the press.

In the administration of Indian lands by the Office of Indian Affairs there has been active cooperation on the part of the Geological Survey. This has been accomplished by the geologic examination of these lands prior to their leasing. The prompt publication of the results obtained by the geologist has proved an incentive to the leasing of the particular areas on which reports are made, a guide to the valuation of the leases, and a help in concentrating drilling where conditions are most favorable for large production.

The investigation of the so-called hydrocarbons or oil-shale deposits of the country, begun four years ago by the Survey, has been diligently prosecuted. The extension of the oil shales of the Uinta Basin westward toward Green River in Utah has been mapped, with the discovery of new areas, so that it is now estimated that there is enough of this shale, in beds 3 feet or more in thickness and capable of yielding more than 22 gallons of oil to the ton by distillation, to provide as much as 40,000,000,000 barrels of petroleum. The Uinta Basin contains a vast storehouse of petroleum in this form, the volume of which is better realized when it is recalled that all the oil that has yet been produced in the United States is but about 3,500,000,000 barrels. The oil fields of the United States are now producing a little over 300,000,000 barrels of petroleum a year, which is about two-thirds of all that is yearly taken from the ground the world over. What new oil pools and fields may yet be discovered in other parts of the world, particularly the less explored regions, no one can foretell, but it seems probable not only that oil will be distilled from the shales of the Green River group long after the principal oil fields of the world have been exhausted but also that the total amount that will be obtained from this source may exceed the world's total production of natural petroleum. The standard of richness named in the above estimate is said to be up to the average of the Scotch shale, which has for many years been the basis of a large industry and which is now providing distillate for British naval and military uses.

A report showing the distribution of the oil shales in Colorado and northeastern Utah and giving analyses and the results of rough tests and laboratory experimental distillations, nitrogen determinations, etc., has been issued as Bulletin 641-F, and another report describing the westward extension of the deposits, with additional details as to the composition of the shales, is now ready for publication. A report giving the results of distillation tests of richly bituminous shales in several of the Eastern States has been issued as Bulletin 641-L.

The investigation of the oil shales has been typically a preparedness measure. How soon it will be necessary to draw rapidly from this source remains to be seen, but it is worthy of note that a small commercial plant is already about to begin the treatment of the oil shales near De Beque, Colo., and that several other plants are projected or in process of construction. Undoubtedly the shales will be found somewhat richer under thick cover than where they have been sampled at the outcrop. It is gratifying also to observe that several State surveys are giving attention to the subject of recovering oil from such bituminous shales and of investigating their possible importance as a source of new as well as of already known by-products.

A new map showing the oil and gas fields of the United States and the trunk pipe lines, together with the oil-exporting points, has been prepared under the supervision of J. D. Northrop and is now in process of engraving.

Another branch of war-preparedness work to which precedence has been given in this division during the year is the systematic investigation of reported or little known deposits of minerals which are especially important to the conduct of the war but for which the country is largely dependent on importations, the attention of the public being called to such of these as may with commercial success be made to contribute to the Nation's supply. Among the more important of these minerals are potash, nitrates, manganese, pyrite, tungsten, chromite, tin, antimony, and molybdenum.

The search for commercial sources of potash and nitrates has continued with unabated zeal. As the stocks of imported potash salts have diminished almost to exhaustion and prices for these materials have increased tenfold and even more, the demand for assurance of a certain supply has become more urgent. Fortunately the most indispensable requirements have been met, although with a production in 1916 of less than 5 per cent of the normal consumption before the war, there is still much room for improvement. During the first half of 1917 the rate of production was more than twice that for 1916 and continued improvement is expected.

The greater part of the potash so produced has been derived from mineral sources, although considerable has been obtained from organic materials, such as molasses residue from distilleries and kelp and wood ashes. The most promising source of potash is the saline deposit at Searles Lake, Cal. The first published announcement of this as a potentially valuable deposit of potash was made by the United States Geological Survey in March, 1912, and it is naturally a source of some satisfaction to see this prediction fulfilled, especially as it was regarded as the opposite of scientifically conservative opinion at the time of publication. Considerable potassium sulphate has lso been recovered from the alunite of Marysvale, Utah. This deosit also was the subject of special study by the United States Geoogical Survey and was covered in its early publications on the prosective sources of potash. The Nebraska alkali lakes have made a urprising record of production. Although not of large extent or eeming to offer a great reserve of raw material, the exceptionally igh content of potash in some of these waters made this product ne of the most readily available sources for a commercial output. This source also was early reviewed in the Survey potash publicaions, but though the facts of its potash content were carefully stated, he occurrence was not then given the prominence that some of the other apparently more extensive resources received. For a time the Nebraska lakes held the lead as a source of commercial potash, and hey still yield a very important production.

Besides those projects that have reached more successful development, many enterprises and prospects have been inspected, most of which have been absolutely disappointing. However, the principal efforts of the Government geologists have been directed to the study of raw materials which might become available as a basis of potash manufacture, although naturally this has involved more or less the consideration of processes by which this material could be utilized.

During 1916–17 nearly all the special fund allotted to the potash investigations was devoted to the exploration of buried saline deposits by drilling. The drilling of the well at Cliffside, in Potter County, Tex., was resumed as soon as it was possible to obtain delivery of the necessary equipment and to reorganize the crew after the allotment of funds for the year became available. At the end of June, 1917, this well had reached a depth of 1,657 feet, which approached the limit, 1,800 feet, set in the original plan. This limit was proposed not because it was expected that the salt beds would have been completely penetrated when that depth was reached but because it would cover the depths at which slight showings of potash salts had been reported in this region. Furthermore, it was as far as could probably be drilled with the fund that could be allotted for this purpose in a single year. The salt beds cut in this well have been very carefully tested, but as yet no valuable deposit of potash-rich material has been encountered. The test is conclusive, however, only for that portion of the section that has been explored and applies only to this one locality or district. The possibilities of finding strata of potash salts associated with the salt beds and gypsum occurring in great number and thickness in the "Red Beds" of the Southwest were discussed in the Thirty-seventh Annual Report, pages 12–14.

By courtesy of the owners borings in other areas of the salt-bearing formations in Texas and Oklahoma have also been inspected and the cuttings tested, although, owing to the meager facilities of the Survey for work of this kind, much important boring is undoubtedly going on without adequate inspection with regard to the possibility of finding potash.

Various other lines of investigation have also been followed. A review and more adequate sampling with analysis of some of the large potash-feldspar deposits has been started, and some significant results bearing on the adequacy of the supply of this raw material for a possible future potash industry have been obtained. A report is nearly ready for publication.

The sericite deposits in Georgia and elsewhere have been examined, sampled, and tested for potash, and a review of the important greensand deposits in the Eastern States has been made to ascertain their potash contents. The results of these inquiries have been published.

The general conclusion has been reached that most of the nitrate deposits in this country are superficial and that the amount of nitrate they contain is not sufficient to make them of commercial importance. Yet investigations of all reported discoveries of nitrates have been made. In June, under the auspices of the War Department, H. S. Gale, geologist in charge of the section of nonmetalliferous deposits, made an examination of nitrate deposits in Guatemala.

A general report by E. S. Bastin, describing the graphite deposits of the country and including information as to several recently discovered and important deposits of flake graphite, has been submitted and is being prepared for publication.

The mica resources of the Eastern States are reviewed by D. B. Sterrett in a comprehensive report now ready for transmission, giving special attention to some of the more important areas.

Systematic examinations, amounting to a qualitative and quantitative census, of the known or reported deposits of platinum, pyrite, manganese, tungsten, chromite, tin, vanadium, strontium, nickel, and antimony have been in progress. Toward the end of the year cooperation in this work has been extended by State geological surveys and geologists of State defense councils.

With the cooperation of a number of State geological surveys, especially in the southern Appalachian region, special attention has been given to the problem of mining domestic pyrite of satisfactory grade sufficiently near the points of consumption and in quantities sufficiently large to take the place of a portion of the pyrite supply which has formerly been imported from Spain. Particular attention has been given also both to the sulphur deposits that may be made available and to the pyrrhotite that it will perhaps be necessary to utilize in making the large amounts of sulphuric acid needed in the manufacture of munitions and of commercial fertilizers.

The search for manganese, which is indispensable in the production of high-grade steel, has been even more comprehensive and systematic.

With the cooperation of geologists and of engineers every reported manganese deposit is in process of investigation and of qualitative and quantitative estimation, with a view to ascertaining the possible outputs of different grades of ore, this year, next year, and the year following. The more important deposits have been and are now under investigation by the geologists of the metalliferous and alloy sections of the division. Furthermore, through the cooperation of the Bureau of Mines and the War Minerals Committee, a joint committee composed of representatives of the Association of State Geologists, the geology committee of the Council of National Defense, the American Institute of Mining Engineers, the Mining and Metallurgical Society of America, the Bureau of Mines, and the Geological Survey, plans have been made to furnish the expert advisory services of some of the most eminent and well-known engineering and mining specialists of the country, who have patriotically volunteered to give practical professional advice to the miners of pyrites, tin, and manganese in certain districts where there is greatest need for such counsel as to mining and milling methods.

To render fuller service to the producer in marketing his ores and to the steel or alloy manufacturer in procuring his domestic ores, the Survey has established an efficient system of bringing them together by correspondence. To give the industry more ample data on production, while furnishing the Government with information as to the rate at which the domestic production is being built up and the rate at which imports may be discontinued, the Survey has planned the quarterly collection and compilation of reports of production of pyrites and manganese, and it is probable that this system of reporting will at an early date be placed on a monthly basis.

An investigation of the platinum deposits of the United States was undertaken early in the spring by L. M. Prindle and J. M. Hill. This work is conducted with close cooperation of the California State Mining Bureau and the State Council for Defense and is designed to cover completely the platinum deposits and possible points of origin of platinum in northern California and southwestern Oregon.

Another timely public service in which a number of the areal geologists and physiographers are engaged is the preparation of two geologic and geographic manuals covering the New England and Virginian regions. These papers, which are prepared on the recommendation of and in cooperation with the geography committee of the National Research Council, will describe the geologic features of the provinces and their origin, and though designed for general educational purposes will give special attention to the inclusion of matter of greatest value in military training and the strategy of the regions covered. Other similar manuals covering other military departments are in prospect. Plans are also being formulated for the preparation and printing of interesting and instructive popular descriptions of the geologic features and their origin in the Army cantonments and surrounding areas. These popular descriptions, with accompanying military data, are to be printed on the backs of the topographic maps of areas including the vicinity of the cantonments.

The popular appreciation of the educational work of the Survey in the publication of the guides to the routes of four western railways has necessitated the issue of new editions of these bulletins. During the year the manuscript and illustrations for a similar guide to the route of the Denver & Rio Grande Railroad in Colorado and Utah has been submitted, but its publication is likely to be delayed for the issue of reports immediately connected with the successful prosecution of the war.

In general the work in economic geology has gone forward as vigorously as the available personnel and funds would permit. The metallographic studies of certain metalliferous ores and the general investigations of the geology and mineral deposits of mining districts mentioned in last year's report have made good progress. A report on the mining districts of Utah has been submitted by B. S. Butler and is now in process of editing and illustration. A revised and much extended description of the enrichment of sulphide ores, by W. H. Emmons, has been issued as Bulletin 625, and a general report on tungsten minerals and deposits, by F. L. Hess, has appeared as Bulletin 652. The report "Useful minerals of the United States," greatly amended and enlarged by F. C. Schrader and others, has been issued as Bulletin 624.

A professional paper on the geology and copper deposits of the Ray and Miami districts of Arizona, by F. L. Ransome, is nearly ready for transmission, and the general descriptions forming the main part of an exhaustive report on the Leadville district have been nearly completed by Prof. J. D. Irving. Other reports covering smaller regions are noted on later pages under the names of the several States. E. S. Larsen is preparing a report on the microscopic determination of known opaque minerals. This extensive work, the publication of which may be delayed for a time, will probably constitute a manual on the subject for the use of geologists, teachers, and students.

The introductory chapter, by M. R. Campbell, of Professional Paper 100, "The coal fields of the United States," has been issued, together with a large map showing the distribution of the coal fields of the country and the ranks of the coals. In this chapter are given short, summary descriptions of the different coal fields, with discussions of the character and qualities of the fuels, representative analyses, and estimates of the coal reserves in the various fields and of the several ranks. A second part, prepared through the courtesy of Dr. J. A. Bownocker, State geologist of Ohio, and presenting somewhat in detail the distribution, qualities, and quantities of the coals in the al-bearing counties of that State, is now nearly ready for issue. arts of Professional Paper 100 describing the coal fields of a num- r of other States have been written, but publication of them is de- yed for the preparation and publication first of papers on several her areas in the Appalachian region.

Notwithstanding some curtailment of the so-called scientific work f the division on account of economic examinations forming a part f the war work, the investigations current in the sections of areal eology, Coastal Plain investigations, and paleontology and stratig- aphy have been fruitful of important results. Besides a number f minor papers noted elsewhere, mention may here in particular be ade of the transmission by F. Canu, of Paris, France, and R. S. assler, of the National Museum, of the results of their long and earching studies on American early Tertiary Bryozoa; by F. H. Knowlton of his conclusions as to the Laramie flora of the Denver Basin, with a review of the Laramie problems; by E. W. Berry of n instructive general discussion of the middle and upper Eocene loras of southwestern America; by D. D. Condit of a description of he Paleozoic and Mesozoic stratigraphy of southwestern Montana; nd by R. W. Stone and others of a report treating fully the gypsum deposits of the United States.

Progress has been made in the preparation of the report by T. N. Dale on the marbles of the Southeastern States, the work on which has been done in cooperation with the Bureau of Mines, Bureau of Standards, Office of Public Roads and Rural Engineering, and the State geological surveys of Georgia, Alabama, and Tennessee. A general description of the Tennessee marbles, prepared by Mr. Dale and C. H. Gordon, of the State Survey, has been submitted to that organization for publication.

WORK OF THE SECTIONS.

The scope of operations of the several sections of the division of geology is briefly outlined in the following synopsis:

1. The section of eastern areal geology—Arthur Keith, geologist, in charge—conducts reconnaissance and detailed work in areal or general geology in regions east of the one hundredth meridian. The work of this section is carried on in close cooperation with several State surveys and university departments of geology, an effort being made to coordinate the work of all participants. During the year the operations of the section have covered areas in Alabama, Arkansas, Illinois, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, and West Virginia.

2. The work of the section of western areal geology (west of the one hundredth meridian)—Sidney Paige, geologist, in charge—cor-

responds to that of the section of eastern areal geology and is similar in scope. The work of this section has included areal mapping and descriptions of areal geology in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming.

3. The section of Coastal Plain investigations—T. W. Vaughan, geologist, in charge—is occupied with the study of the geology of the Atlantic and Gulf Coastal Plain of the United States in the broadest practicable way. The subjects of its investigations include physiography, stratigraphy, geologic structure, paleontology, the character and origin of the sediments, and the ground waters. During the fiscal year, especially since February, the efforts of the members of the section have been devoted mostly to compiling, digesting, and systematizing information bearing on the military preparation of this country. In cooperation with the ground-water division of the water-resources branch, the section has compiled 23 digests of the water resources of the border areas of the United States, which have been transmitted in duplicate to the Secretary of War by the Secretary of the Interior.

Investigations have been made, or reports prepared, on areas in Alabama, Arkansas, California, Delaware, Florida, Georgia, Louisiana, Maryland, Massachusetts, Mississippi, North Carolina, Rhode Island, South Carolina, Texas, Virginia, the Canal Zone, and the West Indies.

4. The section of glacial geology—W. C. Alden, geologist, in charge—is engaged in the study of the work of glaciers, the glacial and interglacial deposits and the contemporary deposits of the bordering regions, and the geologic history of the continent during the Quaternary period. The geologists occupied with those varied and specialized problems are charged with the classification and mapping of the Quaternary deposits of the glaciated regions. The work of this section during the year has comprised field studies and mapping or the preparation of reports covering areas in California, Illinois, Iowa, Massachusetts, Michigan, Minnesota, Montana, North Dakota, Oregon, Pennsylvania, Vermont, Washington, and Wisconsin.

5. The section of paleontology and stratigraphy—T. W. Stanton, geologist, in charge—deals with the classification and correlation of the sedimentary rocks of the entire country, and its work involves the study of all North American fossil faunas and floras and their comparison with those of other parts of the world. In this work it has the active cooperation of the United States National Museum in the identification and study of vertebrate fossils collected by the Survey. During the year members of the section have reported on fossils from Canada, China, Colombia, Cuba, the Galapagos Islands, Patagonia, Peru, the Dominican Republic, and Uruguay, in addition

to their usual routine work on numerous and large collections of fossils obtained in the different States and submitted by the geologic field parties. Some of the more important general studies of the year are as follows: A revised and enlarged catalogue of the Mesozoic and Cenozoic plants of North America has been almost completed. The pentremites of the Mississippian from Missouri, Illinois, Indiana, Kentucky, Tennessee, Virginia, and Alabama have been studied and classified and the Mississippian corals referred to the genus *Lithostrotion* have been described. The Silurian Ostracoda of the Appalachian region, especially those of Clinton age, have been studied with special reference to their bearing on stratigraphy.

6. The section of the geology of metalliferous deposits—F. L. Ransome, geologist, in charge—not only studies metalliferous deposits and mines and investigates the conditions and modes of ore deposition but also carries on reconnaissance and detailed geologic examinations of many new districts. The work of the section has embraced the investigation of metalliferous deposits in Arizona, California, Colorado, Idaho, Kansas, Minnesota, Missouri, Montana, Nevada, New Mexico, Oklahoma, Oregon, Tennessee, Utah, Virginia, Washington, and Wyoming.

The subsection of petrology—E. S. Larsen, jr., geologist, in charge—because of its intimate relation to the study of metalliferous deposits, is attached to this section and is charged with the critical review of the petrologic work and the determination of general petrologic material submitted. The rock-cutting laboratory is under the supervision of the chief of this subsection.

7. The section of the geology of nonmetalliferous deposits—H. S. Gale, geologist, in charge—is concerned with the study of the deposits of nonmetallic ores and minerals, exclusive of fuels, and with the geologic investigation and mapping of regions in which such minerals or deposits are of paramount importance. During the year the greater part of the work of the section has been divided between the investigation of raw materials possibly available as sources of commercial potash in various parts of the United States and special investigations relating to reported nitrate deposits; further investigation and classification of the phosphate-bearing lands in Idaho and Montana, a review of the gypsum deposits of the United States, and investigations relating to building stones have also been carried on. The work of the section relates in particular to Alabama, Arizona, California, Colorado, Georgia, Idaho, Indiana, Iowa, Kentucky, Michigan, Montana, Nebraska, Nevada, New Mexico, North Carolina, Ohio, Oklahoma, Oregon, Tennessee, Texas, Utah, Virginia, and West Virginia.

8. The section of the geology of eastern coal fields—G. H. Ashley, geologist, in charge—conducts examinations of areas east of the one hundredth meridian that contain coal. The work of the section dur-

ing the year has been done in cooperation with the State surveys of Illinois, Ohio, Pennsylvania, Tennessee, and Virginia.

9. The section of the geology of western coal fields—M. R. Campbell, geologist, in charge—conducts examinations and surveys in the coal-bearing regions west of the one hundredth meridian, similar to those made by the section of eastern coals. The greater part of the work of the western section has consisted in classifying and mapping coal lands of the public domain in Colorado, Montana, New Mexico, Utah, Washington, and Wyoming.

10. The section of the geology of oil and gas fields—David White, chief geologist, in charge—is engaged in the examination of the geologic structure and oil and gas indications in areas which are thought to have promise of oil and gas; in studies of the mode of occurrence and mutual relations of oil, gas, and water, and their relation to the structure and to the character and composition of the sands in developing pools; in observation of the chemical relations between oil, water, and the sediments in oil fields; and in the investigation and utilization of hydrocarbon or oil shales. During the year work has been done in or reports written on areas in Alabama, Arkansas, California, Colorado, Florida, Georgia, Indiana, Kentucky, Louisiana, Mississippi, Missouri, Montana, Nevada, New Mexico, Ohio, Oklahoma, Pennsylvania, South Dakota, Texas, Utah, West Virginia, and Wyoming.

11. The section of the geology of iron and steel alloy metals—E. F. Burchard, geologist, in charge—was established in April for the purpose of conducting examinations and economic surveys of deposits of iron and the ores of the alloy metals—chromite, manganese, tungsten, molybdenum, nickel, vanadium, etc. It is essentially a war-metal section. Its work in the search for, classification and estimation of, and assistance in the development of deposits of the alloy metals, now largely imported and most indispensably necessary to the conduct of the war, has extended to Alabama, Arizona, Arkansas, California, Colorado, Georgia, Iowa, Minnesota, Oregon, Tennessee, Utah, and Virginia.

The section of geologic-map editing—G. W. Stose, geologist, in charge—is a part of the publication branch, but its work is so intimately associated with the work of the individual geologists in the division of geology that it is administered as a part of the geologic branch, in which the chief of the section is an active geologist, whose geologic field investigations are reported in the sections to which they pertain. The office work of this section is described on pages 159–160.

ASSISTANCE TO OTHER DIVISIONS.

In addition to performing work in their respective sections, a considerable number of the geologists in the sections of metalliferous and nonmetalliferous deposits and several geologists in the sections of eastern and western areal geology have prepared for publication, in the annual volumes of Mineral Resources, reports on the production and statements of the industrial conditions relating to a large number of mineral resources with which they are especially familiar.

The paleontologists of the division report on fossils collected by the division of Alaskan mineral resources and are called upon to classify fossils for the National Museum and occasionally for foreign Governments and for other scientific institutions.

Close cooperation, with constant interchange of information, exists between the geologic branch and the water-resources branch in the investigation of underground-water movements and supplies and of sedimentary deposition. Members of the land-classification board serve in the geologic field parties, and a number of economic geologists of this division serve as members of the special committees of the land-classification board.

COMMITTEE ON GEOLOGIC NAMES.

The committee on geologic names is a standing committee of the geologic branch and consists of T. W. Stanton (chairman), G. W. Stose, W. T. Lee, Sidney Paige, and L. W. Stephenson. The chiefs of section of the division of geology and the chief of the division of Alaskan mineral resources also serve as associate members, each of whom is invited to attend meetings at which matters pertaining to his section or division are under consideration. Authors of manuscripts under discussion are expected to be present or to select someone to present their views. On each question the individual opinions of the persons present are recorded and forwarded to the chief geologist, who makes the decision, subject to appeal to the Director. The records are kept by the secretary, Miss M. G. Wilmarth, who also examines all manuscripts submitted for publication and compares the geologic nomenclature and classification used in them with the standards in current use by the Geological Survey. During the year 117 manuscripts, comprising 17,900 pages and involving about 3,190 geologic names, have been examined. Good progress has been made in preparing the manuscript of a stratigraphic lexicon of geologic formations and in compiling general correlation charts.

COMMITTEE ON PHYSIOGRAPHY.

The physiographic committee, one of the standing committees of the geologic branch, was reorganized March 1, 1916, and now consists of M. R. Campbell (chairman), F. E. Matthes, O. E. Meinzer, E. W. Shaw, and P. S. Smith. One of the important duties of the committee is to examine and pass upon papers of a physiographic character or chapters on physiography in other papers. In accordance with these instructions the committee has during the year examined, corrected, and approved 10 folio texts, 5 water-supply papers, and 5 papers of a general geologic character. The committee submitted and recommended for publication a descriptive text for the back of the Mount Rainier National Park map, prepared by F. E. Matthes.

During the year the chief geologist approved the map prepared by the Association of American Geographers, showing the physiographic provinces of the United States, and copies were distributed to geologists with the statement that the committee was prepared to consider all suggestions regarding alteration of boundary lines or changes in nomenclature. Some progress has been made in delineating these lines in greater detail. Progress has also been made in collecting and carding definitions of physiographic terms for the use of the committee in preparing new and standard definitions.

The physiographic committee, in conjunction with the geography committee of the National Research Council, has begun the preparation of a series of geographic handbooks containing information regarding the geology and physiography of the country useful in both general and military instruction. Two such handbooks have been undertaken—one for New England and one for the Middle Atlantic States of Virginia, West Virginia, Maryland, and Delaware. It is hoped that these will be completed at an early date, so that they may be available at the military training camps.

GENERAL SUMMARY OF GEOLOGIC WORK.

The geologic work of the division has extended into every State, the Canal Zone, and the West Indies. Systematic detailed surveys in metal-mining districts were carried on in Arizona, California, Minnesota, Nevada, New Mexico, and Utah, and reconnaissance studies of metal-mining districts were made in Alabama, Arizona, Colorado, Idaho, Kansas, Missouri, Montana, Nevada, New Mexico, Oklahoma, Oregon, Tennessee, Utah, Virginia, Washington, and Wyoming. Potash and nitrate prospects were investigated in the States containing semiarid regions, in the "Red Beds" region of the Southwest, and through the analytical testing of brines coming from many oil, water, and salt wells in other portions of the country. Other nonmetalliferous deposits of one kind or another were investigated in nearly every State. Coal fields were examined in Colorado, Illinois, Montana, New Mexico, Ohio, Pennsylvania, Tennessee, Utah, Virginia, Washington, and Wyoming; and studies with mapping of structure with reference to oil and gas were made in Alabama, California, Colorado, Florida, Georgia, Illinois, Kentucky, Louisiana, Mississippi, Montana, New Jersey, New Mexico, Oklahoma, Pennsylvania, Texas, Virginia, and Wyoming. Reports describing mineral deposits previously examined in other States and not mentioned above are now in preparation. General and detailed geologic and paleontologic work was continued in all regions of the country, including a large amount of geologic work in connection with the examination of the economic resources just mentioned. Work in classifying lands of the public domain and of Indian reservations was carried on in Arizona, California, Colorado, Idaho, Montana, New Mexico, North Dakota, Oregon, Utah, Washington, and Wyoming.

During the year the geologists engaged in examinations requiring areal geologic mapping or in classifying the lands have covered 28,500 square miles with exploratory and reconnaissance surveys and 6,701 square miles with geologic mapping in detail.

Field examinations for the classification of lands in the public-land States have extended over 22,875 square miles.

WORK OF THE DIVISION BY STATES.

ALABAMA.

Examinations of the marbles of Alabama were completed by T. N. Dale, who has nearly finished the Alabama section of a report on the marbles of the southern Appalachian region.

The Hatchetigbee uplift, in Choctaw, Clarke, and Washington counties, was studied and mapped by O. B. Hopkins, whose report on the oil and gas prospects of the area (Bulletin 661-H) is now in the hands of the printer.

At the suggestion of the Weather Bureau, Mr. Hopkins investigated the geologic structure and the evidence of disturbance caused by the earthquake of October 18, 1916, in the region of Pell City and Ironaton, Ala. A report showing the movement to have taken place along an old fault, seen near Ironaton, was transmitted to and published by the Weather Bureau.

In May, 1917, a structural reconnaissance along Chattahoochee River below Columbus was carried out by Mr. Hopkins and C. W. Cooke for the purpose of testing the reported presence of an anticline. Mr. Cooke, with T. W. Vaughan, prepared a digest of the ground waters of Alabama for the use of the War Department.

A monograph entitled "Later Eocene fossil plants of southeastern North America," by E. W. Berry, transmitted for publication, contains descriptions of the later Eocene floras of the State; and a "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, transmitted for publication, contains accounts of Eocene and lower Oligocene Bryozoa from Alabama.

The Catahoula formation of the State is discussed by G. C. Matson in a paper entitled "The Catahoula sandstone" (Professional Paper

98–M), and the Citronelle formation is discussed by Mr. Matson in a paper on "The Pliocene Citronelle formation of the Gulf Coastal Plain" and by Prof. E. W. Berry in a paper on "The flora of the Citronelle formation" (both in Professional Paper 98–L). A reconnaissance of the bauxite deposits of the State was made by J. M. Hill, and a brief paper on the Gold Log mine, Talladega County, by E. S. Bastin, was published as Bulletin, 640–I.

The texts for the Bessemer-Vandiver and Montevallo-Columbiana folios have been submitted by Charles Butts and are now in process of criticism.

Manganese and ore deposits in Murphrees Valley, northeast of Birmingham, were examined in the fall of 1916 by E. F. Burchard, who also sampled three deposits of gray iron ore near Sylacauga for analysis for potash content.

A brief reconnaissance of the graphite deposits in Chilton, Clay, and Talladega counties was made by H. G. Ferguson in the spring of 1917.

ARIZONA.

The preparation of a professional paper on the copper deposits of the Ray and Miami districts was continued when administrative duties permitted, by F. L. Ransome, and has been practically completed. The work done also contributes largely toward the Ray folio, which Mr. Ransome has in hand. A paper on "Some Paleozoic sections in Arizona," prepared by Mr. Ransome, appeared as Professional Paper 98–K.

A field investigation of some of the gypsum deposits of this State was made by R. W. Stone, the results being incorporated in a general report on "The gypsum deposits of the United States."

Studies of the stratigraphy and historical geology of a portion of the Grand Canyon of the Colorado were continued by L. F. Noble, who, with the late J. F. Hunter, jr., prepared a paper entitled "A reconnaissance of the Archean complex of the Granite Gorge, Grand Canyon, Ariz." (Professional Paper 98–I).

A report of a geographic and hydrographic reconnaissance of parts of Arizona, New Mexico, and Utah, by Prof. H. E. Gregory, has been published as Water-Supply Paper 380, under the title "The Navajo country." A more extended paper by Prof. Gregory on the geology and geography of the region is now in course of publication as Professional Paper 93.

During the fall and winter of 1916 F. C. Schrader made an examination of lands on the Gila Reservation as to their mineral or nonmineral character for the Office of Indian Affairs.

Deposits of tungsten and other rare metals in various parts of the State were investigated by F. L. Hess in the spring of 1917.

ARKANSAS.

A digest of the ground waters of the Coastal Plain of Arkansas, for the use of the War Department, was prepared by L. W. Stephenson.

A monograph entitled "Later Eocene fossil plants of southeastern North America," by E. W. Berry, transmitted for publication, contains data on the later Eocene of Arkansas.

A study of the lead and zinc deposits in the Yellville quadrangle was made by E. F. Burchard. The results will be published in the Yellville folio. The Hot Springs folio, by H. D. Miser, has been revised in order to incorporate results of the field work of the previous season and is now being prepared for publication. During the field season Mr. Miser completed the mapping of terrace deposits and Trinity gravels in the DeQueen and Caddo Gap quadrangles and revised some mapping in the northwest corner of the Caddo Gap quadrangle. The text for the folio covering these quadrangles is nearly completed. Mr. Miser also made an examination of antimony mines at Gillham, of the lead and zinc mine at Davis, and of manganese deposits in the Caddo Gap and DeQueen quadrangles. A report by him on the manganese deposits of these quadrangles is now in press.

During the year the Eureka Springs-Harrison folio, by A. H. Purdue and H. D. Miser, has been published. These geologists also have in preparation a report on "Asphalt deposits of Pike and Sevier counties, Ark." A report by them on the "Gravel deposits of the Caddo Gap and DeQueen quadrangles" has been transmitted for publication, and a report on "Diamond-bearing peridotite in Arkansas" is in course of preparation by Mr. Miser.

Collections of invertebrates from formations of Chester and Pottsville age were obtained by G. H. Girty, who continued the description of the fauna of the Morrow formation. Paleozoic invertebrate fossils from the Yellville quadrangle were studied by E. O. Ulrich.

The structure at several places in the Arkansas coal field was examined by David White, who sampled the coals and richly carbonaceous shales at a number of points in the Fayetteville quadrangle and in the northwest corner of the State in order to obtain evidence as to the possibility of finding productive oil pools in the area.

Analyses of greensands, sampled to show their potash content, are given in Bulletin 660–B, by G. H. Ashley.

CALIFORNIA.

A paper on tungsten deposits of northwestern Inyo County, prepared by Adolph Knopf, was issued as Bulletin 640–L. A geologic reconnaissance report on the Inyo Range and the eastern slope of the

Sierra Nevada (Professional Paper 110), submitted by Mr. Knopf, is ready for publication.

A geologic examination of the reported strontium deposits near Barstow was made by Mr. Knopf, who submitted a brief report on the matter for incorporation in the statistical report on strontium in 1916, by J. M. Hill. A more complete statement has been submitted by Mr. Knopf for publication in "Contributions to economic geology." Newly discovered strontium deposits in San Bernardino and Imperial counties were examined by F. L. Hess.

Many potash projects about San Francisco and Los Angeles, the six plants obtaining potash from kelp near San Pedro, and the two plants near San Diego were visited by H. S. Gale.

The investigations of California oil fields were continued. The area of the Salinas Valley mapping was extended by W. A. English, who covered, either in detail or detailed reconnaissance, the larger part of the San Miguel and Cholame quadrangles and portions of the Paraiso Springs, Priest Valley, Coalinga, Lost Hills, and McKittrick quadrangles. His report on the "Geology and oil prospects of the Salinas Valley–Parkfield area" is ready for review and publication.

A special detailed study of the Belridge–Lost Hills district was carried through by R. W. Pack and Mr. English. The mapping and general description of the geology has been finished by Mr. English, but completion of the report is delayed by the resignation of Mr. Pack to enter private service. A report on the geology of the Sunset-Midway field, by Mr. Pack, is nearly ready for submission.

The results of the study of the water conditions with reference to the oil and the structure of the sands in the Coalinga field, by G. S. Rogers, are embodied in a report almost completed but interrupted on account of the assignment of Mr. Rogers to similar field examinations in the Gulf Coastal Plain.

Materials embracing manuscript and maps for a folio covering the Ventura district have been submitted in preliminary draft by Ralph Arnold, by whom the work was begun before his resignation from the Survey. In these studies Dr. Arnold has been assisted by W. A. Pemberton, who is joint author. The region of new development to the east of that covered by Messrs. Arnold and Pemberton was visited near the end of the year by W. S. W. Kew, who, assisted by J. A. Buwalda, will extend the structural investigations. A report by G. S. Rogers on the "Chemical relations of the oil-field waters of the San Joaquin Valley, Cal.," has been issued as Bulletin 653.

Description of the Tertiary invertebrate faunas of California and other Pacific Coast States was continued by W. H. Dall; a report on Tertiary plants from Marysville Buttes was made by F. H. Knowlon; and Cretaceous invertebrates from the west side of San Joaquin Valley were identified by T. W. Stanton.

The geologic studies in the Yosemite National Park, undertaken for the preparation of a popular guide to the geology of the park, were completed by F. E. Matthes and F. C. Calkins. Mr. Matthes devoted his time to detailed studies of the ancient Tuolumne Glacier and distinguished two periods of glaciation. He also gave particular attention to the physiography of the region, mapping in detail about 190 square miles and on a reconnaissance scale about 50 miles. Mr. Calkins completed detailed studies of the bedrock geology, mapping 30 square miles in detail and 95 square miles on a reconnaissance scale. He also made a detailed study of a section of Merced River from the Great Valley to Yosemite Park. These two geologists are preparing a professional paper which will describe this region, with a cross section from the Great Valley of California across the Sierra Nevada.

Chromite, of which California is by far the greatest producer, was the subject of an exhaustive investigation by J. S. Diller, who made a reconnaissance survey of about 2,000 square miles, studying the sources of supply and endeavoring to increase the production.

The mild volcanic activities of Lassen Peak continued, and during July and August Mr. Diller made a reconnaissance of about 400 square miles in this region, gathering data for a bulletin on the Lassen Volcanic National Park, which is now well advanced.

The field work for a comprehensive report on the "Physiography and geology of southern California" has been completed under agreement by R. T. Hill, and office work on its preparation is far advanced.

The detailed mapping for a folio on the Mariposa quadrangle was begun by J. F. Hunter, jr., who covered about 400 square miles. Mr. Hunter lost his life by accidental drowning May 23, 1917, while engaged in field examinations in Georgia.

A study of the Tertiary formations adjacent to the Mohave Desert was undertaken by L. F. Noble and R. E. Dickerson late in June, with a view to establishing the relations between the continental and marine Tertiary formations in southern California. Mr. Noble continued detailed studies of the Rock Creek, San Antonio, and Hesperia quadrangles, mapping in all about 55 square miles. It is planned to publish a paper on that part of these quadrangles adjacent to the great San Andreas rift zone.

To confirm the report that the oil-bearing shales in the Tertiary formations of California, notably in Ventura County, were capable of yielding large quantities of oil on distillation, field examinations were made by D. E. Winchester, W. A. English, and L. F. Noble, who collected samples for distillation tests by the Bureau of Mines.

Professional Paper 98–T, "The reef-coral fauna of Carrizo Creek, Imperial County, Cal., and its significance," by T. W. Vaughan, contains an account of a coral fauna of purely Atlantic affinities at the head of the Gulf of California.

Descriptions of molybdenite near Ramona and of an occurrence of nickel ore in San Diego County are given by F. C. Calkins in Bulletin 640-D.

Glacial studies were carried on in the Yosemite Valley and vicinity from July 8 to 15 by Frank Leverett, in connection with a western trip.

COLORADO.

The study of the physiographic history of the San Juan Mountains and the mapping of the Quaternary formations within that range were continued during the field season by W. W. Atwood, assisted by K. F. Mather and Arthur Iddings. While this work has been in progress a number of serious engineering problems have been encountered in connection with the reservoir sites in the eastern portion of the range. Most of these reservoirs are in mountain canyons, and the sites for the dams have been selected where the valleys are somewhat constricted, either by glacial moraines or landslide deposits. A special study of the geology associated with these reservoir sites has been made, and a report has been submitted by Mr. Atwood, entitled "Relations of landslides and glacial deposits to reservoir sites in the San Juan Mountains."

In the Creede, Summitville, and Del Norte quadrangles the detailed examination and mapping of the Quaternary formations was completed for an era of 1,600 square miles. Reconnaissance examinations were made in an area of 150 square miles bordering the Del Norte quadrangle.

Studies of the igneous rocks in the San Juan region were continued by E. S. Larsen under the general supervision of Whitman Cross. Exploratory examinations covered about 700 square miles, and a detailed reconnaissance was also made covering about 600 square miles in the Del Norte quadrangle and adjoining areas.

A reconnaissance of about 400 square miles in and near the Rocky Mountain National Park was made by W. T. Lee, who submitted a popular descriptive report thereon for publication by the National Park Service. About 500 square miles in northeastern Colorado was covered by Mr. Lee in exploratory examinations for the investigation of the stratigraphy of the Cretaceous rocks along the western foothills of the Rocky Mountains. Mr. Lee submitted a report entitled "Notes on the Jurassic and Cretaceous of the Rocky Mountains" and a paper entitled "Physiography of the Rocky Mountain National Park."

The detailed report on the "Economic geology of Gilpin County and adjacent parts of Clear Creek and Boulder counties," by E. S.

Bastin and J. M. Hill, appeared during the year as Professional Paper 94. Gilpinite, a new uranium mineral from this region, has been described by E. S. Larsen in an unofficial publication.

A chapter on the oxidized zinc ores of Leadville, by G. F. Loughlin, has been transmitted for inclusion in the monograph on the Leadville district, the text for which has just been submitted to the Survey by J. D. Irving.

Special inquiry was made into the reported discovery of very extensive deposits of alunite, which has been viewed as a possible source of potash, on Pintados Peak, in the San Juan Mountains, southern Colorado.

The question of the practicability of developing a source of nitrate from the "brown spots" in Colorado was investigated by H. S. Gale, in conference with Prof. W. P. Headden, of the State Experiment Station, Fort Collins. Mr. Gale also examined numerous reported discoveries of potash and nitrate in the vicinity of Denver.

In order to procure data as to the value of certain mine tailings as possible sources of potash, samples of potash-rich tailings from dumps of mills in the vicinity of Cripple Creek were collected by F. L. Hess for more detailed study.

A monograph on the Laramie flora of the Denver Basin was submitted for publication, and the description of the flora of the Denver formation was nearly completed by F. H. Knowlton, who also wrote a paper on a dicotyledonous flora from the type section of the Morrison formation. Cretaceous invertebrates from northern Colorado were reported on by T. W. Stanton.

The Colorado Springs folio (No. 203), by G. I. Finlay, was issued during the year.

The reconnaissance examinations of the oil shales in northwestern Colorado and northeastern Utah, with field tests to determine their capacity to yield petroleum by destructive distillation, were continued by the party in charge of D. E. Winchester. Some of the preliminary results of the work of this season were combined with the report for the preceding season and published as Bulletin 641–F. Interest in the possibilities of these oil shales has been so widespread that it was found necessary to print a second edition of the bulletin. Additional data are contained in a paper just submitted by Mr. Winchester, giving the results of his searches for oil shale in Utah and Nevada also.

CONNECTICUT.

The study of the geology of southern Connecticut was in the spring of 1917 continued by the Geological and Natural History Survey of Connecticut under the direction of Prof. H. E. Gregory, in cooperation with the Federal Survey.

The geography of this State is being described for a manual of the geography of New England, a popular report, designed also for military use, now in preparation in cooperation with the geography committee of the National Research Council. The work is done by W. M. Davis for the Council and by Arthur Keith for the Survey.

DELAWARE.

The folio on the Elkton and Wilmington quadrangles, including parts of Pennsylvania and Maryland, is in course of publication.

Analyses of greensands from several parts of the State, sampled to show their possible value as sources of potash, are given by G. H. Ashley in a report entitled "Notes on the greensand deposits of the eastern United States" (Bulletin 660-B).

FLORIDA.

G. C. Matson discusses the Catahoula formation in Florida in a paper entitled "The Catahoula sandstone" (Professional Paper 98-M), and the Citronelle formation in a paper on "The Pliocene Citronelle formation of the Gulf Coastal Plain" (Professional Paper 98-L).

A digest of the ground waters of Florida was prepared, for the use of the War Department, by C. W. Cooke and T. W. Vaughan.

A manuscript on the stratigraphic position and faunal associates of species of orbitoid Foraminifera of the genus *Orthophragmina* from Georgia and Florida, by C. W. Cooke, and one on the species of *Orthophragmina* from the Eocene of Florida and Georgia, by J. A. Cushman, were transmitted for publication (Professional Paper 108-G).

A "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, transmitted for publication, contains descriptions of upper Eocene and lower Oligocene Bryozoa.

A report on the Mollusca of the Alum Bluff formation, by Miss Julia Gardner, is almost completed. An investigation of the fossil corals of the southeastern United States, including Florida, was continued by T. W. Vaughan. A paper "On reported Pleistocene human remains at Vero, Fla.," by Mr. Vaughan, appeared in the Journal of Geology, December, 1916.

A study of the mechanical composition of Recent sediments from Florida, by E. W. Shaw, is in progress. A paper on the fauna and correlation of the Nashua marl was written by W. C. Mansfield, and several collections of Tertiary invertebrates were reported on by W. H. Dall.

In June an examination of the geologic structure and of reported il and gas indications in the western part of the State was begun at the request of the State geologist, who cooperated with O. B. Hopkins, of this Survey, in the field investigations.

GEORGIA.

At the request of the State geologist of Georgia an examination of the reported oil and gas and structural indications in southern Georgia was made by a cooperative party in which the Federal Survey was represented by O. B. Hopkins, C. W. Cooke, and J. F. Hunter, jr. The principal results of the investigation, which covered the region along Chattahoochee River from Columbus to Alaga and portions of Decatur, Miller, and Grady counties, have been communicated for publication by the daily press.

Field work and a part of the office work in connection with the preparation of a chapter on the marbles of Georgia was accomplished by T. N. Dale. The results are to be incorporated with other material in a comprehensive report on the "Marbles of the Southern States."

A reconnaissance of the bauxite deposits of the State was made by J. M. Hill, and field examinations of some of the feldspar deposits of Georgia, with special reference to their potash contents, were made by F. J. Katz.

A report entitled "Deposits of Claiborne and Jackson age in Georgia," by C. W. Cooke, of this Survey, and H. K. Shearer, of the Geological Survey of Georgia, was completed and has been submitted for publication as a part of Professional Paper 120.

A digest of the ground waters of the Coastal Plain of Georgia and geographic data relating to a part of the Coastal Plain were compiled by L. W. Stephenson, for the use of the War Department.

A manuscript on the stratigraphic position and faunal associates of species of orbitoid Foraminifera of the genus *Orthophragmina*, by C. W. Cooke, and one on the species of *Orthophragmina* from the Eocene of Florida and Georgia, by J. A. Cushman, were submitted for publication (Professional Paper 108–G).

A monograph entitled "Later Eocene fossil plants of southeastern North America," by E. W. Berry, transmitted for publication, contains descriptions of upper Eocene fossil plants from Georgia; and a "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, also transmitted for publication, contains accounts of Eocene and lower Oligocene Bryozoa from the State.

The study of the Tertiary corals of Georgia was continued by T. W. Vaughan.

IDAHO.

Widely scattered mining regions in Idaho were visited during the field season of 1916 by J. B. Umpleby and E. L. Jones, who collected data for a general report on the ore deposits of Idaho. The field work upon which this report will be based is now completed, and the manuscript and necessary maps are in preparation.

A detailed report on the "Geology and ore deposits of the Mackay region," by J. B. Umpleby, has been recently issued as Professional Paper 97. A short report on "Lode mining in the Quartzburg and Grimes Pass porphyry belt, Boise Basin," by E. L. Jones, appeared as Bulletin 640–E, and a report on the Pine Creek district, accompanied by a geologic sketch map, also by Mr. Jones, has been submitted for publication.

A history of mining development in Idaho, which was prepared by Dr. W. P. Jenney under agreement, will be utilized in the forthcoming report on the geology and ore deposits of the State, by Messrs. Umpleby and Jones.

Detailed examinations of the phosphate deposits, with mapping of about 400 square miles, in the Henry, Cranes Flat, and Portneuf quadrangles were made by G. R. Mansfield. Field work in the Henry and Cranes Flat quadrangles was completed, both for areal mapping and for phosphate-land classification. Mr. Mansfield began during the winter the preparation of a professional paper on southeastern Idaho, covering the Montpelier, Slug Creek, Crow Creek, Lanes Creek, Freedom, Portneuf, Henry, and Cranes Flat quadrangles. The Carboniferous and Lower Triassic faunas of southeastern Idaho were discussed and characteristic species illustrated by G. H. Girty in a chapter to be embodied in this paper. Collections of Jurassic and Cretaceous invertebrates from southeastern Idaho were reported on by T. W. Stanton.

Mr. Mansfield revised the manuscript of his paper on the Fort Hall Indian Reservation, submitted for publication several years ago.

The text of the Hailey folio has been practically completed by Prof. L. G. Westgate. The Silurian and Ordovician graptolites of the quadrangle have been described by Edwin Kirk for publication in Prof. Westgate's report on the geology of the quadrangle.

A nitrate deposit in the Lanes Creek quadrangle, reported to the Survey by letter, was visited by G. R. Mansfield and found to be not of commercial size and quality.

A paper on the "Genesis of the Success zinc-lead deposit, Coeur d'Alene district," by J. B. Umpleby, has been transmitted for unofficial publication.

ILLINOIS.

The geology of the Shawneetown, Golconda, and Equality quadrangles, in the southern part of Illinois, was examined by Charles Butts, who mapped portions of the Equality quadrangle in detail, the work being carried on in cooperation with the State Geological Survey. A report on "Structure favorable to oil and gas accumulation in Hardin County, Illinois," was prepared by Mr. Butts for publication by the State.

The stratigraphy and paleontology of the Chester group, in Illinois and Kentucky, were studied by G. H. Girty and E. O. Ulrich in a field conference in which G. H. Ashley, F. W. DeWolf, and Stuart Weller also participated. Independent studies of the faunas were subsequently made by all the paleontologists, and a special study of the *Pentremites* was made by E. O. Ulrich.

The manuscript on the Quaternary geology of the Gillespie and Mount Olive quadrangles, prepared for folio publication by Wallace Lee, was revised somewhat by Frank Leverett and W. C. Alden, and the folio is now ready for publication.

INDIANA.

At the request of the Office of the Supervising Architect of the Treasury Department and the Indiana Limestone Quarrymen's Association a field investigation of the so-called Bedford or Salem limestone of Indiana was undertaken by G. F. Loughlin, for the purpose of defining and establishing the grading of the limestone. Tests on the materials collected by Mr. Loughlin are now in progress by the Bureau of Standards, also cooperating. It is expected that the State will join in the work through the areal mapping of the deposits.

A report of the distillation tests of certain of the richly bituminous shales of the State for the purpose of ascertaining their possible yield of oil is given by G. H. Ashley in Bulletin 641–L, "Oil resources of black shales of the eastern United States."

IOWA.

The study of the evidence of an Iowan stage of glaciation, a cooperative investigation by W. C. Alden and M. M. Leighton for the Federal and Iowa geological surveys, respectively, was completed and transmitted to the Iowa Survey for publication.

The iron-ore deposit at Waukon, recently developed and brought to production by improved methods of concentration, was examined by E. F. Burchard in June.

KANSAS.

Examinations of the geologic structure in the region of southern Kansas immediately north of the State line in the vicinity of the Pawhuska quadrangle were made by K. C. Heald in connection with his mapping of the structure of the northwest corner of the quadrangle.

Carboniferous invertebrates from the State were described by G. H. Girty.

Areas in western Kansas that are possibly structurally favorable for the occurrence of oil or gas are described by N. H. Darton in a paper now in process of publication.

KENTUCKY.

A report on the phosphate deposits of Kentucky was completed and transmitted for publication by W. C. Phalen, who was temporarily transferred from the Bureau of Mines in order to complete the work. This report was prepared in cooperation with the State Geological Survey of Kentucky and has been submitted to that organization for publication.

The invertebrates of the Chester group in the State were studied by G. H. Girty and E. O. Ulrich in continuance of the work of the field conference mentioned under the heading "Illinois." The boundary between the Cincinnatian and the Mohawkian was studied in the field by Mr. Ulrich in cooperation with Prof. A. M. Miller, of the University of Kentucky.

A detailed reconnaissance of the stratigraphy and correlation of the Mississippian formations in west-central Kentucky was made by Charles Butts, in cooperation with the State Geological Survey. The report by Mr. Butts, which will be transmitted for publication by the State, is nearing completion. The work is closely related with the work being carried on by Mr. Butts in southern Illinois.

Structural examinations of a part of Allen County were made early in the season by E. W. Shaw and K. F. Mather. A brief statement of the principal conclusions was promptly given publicity, and a report discussing the oil and gas possibilities of the region is now in process of publication.

A report on the structure and oil prospects of the Irvine district by Mr. Shaw is now in press as Bulletin 661-D.

LOUISIANA.

A digest of the ground waters of the Coastal Plain of Louisiana, for the use of the War Department, was prepared by L. W. Stephenson. The manuscript of a report on the clays of Louisiana, by G. C. Matson (Bulletin 660-E), was finished and submitted for publication.

An examination of the sulphur deposits of the State, with special reference to their use in the manufacture of sulphuric acid, was made by P. S. Smith.

The Catahoula formation in Louisiana is discussed by G. C. Matson in a paper entitled "The Catahoula sandstone" and by Prof. E. W. Berry in a paper entitled "The flora of the Catahoula sandstone," both in Professional Paper 98-M, and the Citronelle formation is discussed by Mr. Matson in a paper on "The Pliocene Citronelle formation of the Gulf Coastal Plain" (Professional Paper 98-L).

A monograph entitled "Later Eocene fossil plants of southeastern North America," by E. W. Berry, transmitted for publication, contains descriptions of fossil plants from Louisiana. Eocene invertebrates from the State were identified by W. H. Dall.

In connection with the study of the structure, lithology, and chemistry of the salt domes of the Gulf Coastal Plain examinations of the salt domes in the region of New Iberia were made in June, 1917, by G. S. Rogers.

A report describing the structure and discussing the oil resources of the De Soto-Red River region, by G. C. Matson and O. B. Hopkins, has been issued as Bulletin 661-C.

Inspections of the surficial geology and structural criteria at several points in eastern Louisiana were made in the winter of 1916 by O. B. Hopkins.

MAINE.

The raised Pleistocene shore line in the Portland, Gray, and Buxton quadrangles, Maine, was studied and mapped by F. J. Katz, who also made a reconnaissance examination of part of the Buxton and all of the Berwick and Kennebunk quadrangles. The results of these studies have been incorporated in the Portland-Casco Bay folio, which is being prepared. The study of similar shore lines in the Dover and York quadrangles and of the general areal geology of the Dover quadrangle was continued by Mr. Katz. A field conference was held with Arthur Keith and Laurence LaForge.

A paper on the "Stratigraphy in southwestern Maine and southeastern New Hampshire," by Mr. Katz, is in course of publication as Professional Paper 108-I, and a paper on the Newington moraine, also by Mr. Katz, has been issued as Professional Paper 108-B.

Feldspars at several points in the State were sampled by Mr. Katz to determine their value as possible sources of potash.

MARYLAND.

Office work on the maps and description of the Williamsport quadrangle, which will be a part of the Williamsport-Hagerstown folio, has been well advanced by G. W. Stose. This folio will be published in cooperation with the Maryland Geological Survey, but the quadrangle includes portions of Pennsylvania and West Virginia.

The folio for the Elkton and Wilmington quadrangles, including parts of Delaware and Pennsylvania, prepared by Florence Bascom and B. L. Miller, also in cooperation with the Maryland Geological Survey, is in course of publication. The Tolchester folio (No. 204), by B. L. Miller, E. B. Mathews, A. B. Bibbins, and H. P. Little, also cooperative, has been published.

At the request of the United States Geological Survey a digest of the ground waters of Maryland was prepared for the use of the War Department by Prof. W. B. Clark, State geologist of Maryland.

A "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, transmitted for publication, contains descriptions of early Tertiary Bryozoa from formations in this State.

MASSACHUSETTS.

A report on the physiography, geology, and ground waters of Cape Cod, Nantucket, Marthas Vineyard, Block Island, and the Elizabeth Islands was completed and submitted by Prof. J. B. Woodworth, who also prepared a digest of the water resources of Cape Cod and the islands off the coast of Massachusetts and Rhode Island for the use of the War Department. The field mapping was inspected by T. W. Vaughan in conference with Prof. Woodworth.

Detailed studies of the Cambridge slate, of Pleistocene lake history, and of obscure points in bedrock geology in the Boston and Boston Bay quadrangles were made by Laurence LaForge. Mr. LaForge made reconnaissance examinations of the rocks in parts of the Lawrence and Salem quadrangles, investigated the late Pleistocene submergence of the coast near Newburyport, and carried on semidetailed mapping of the igneous rocks in the northern part of the Newburyport quadrangle. In much of this area Mr. La Forge was accompanied by Arthur Keith. During the field work Mr. LaForge found abundant evidence of a late Pleistocene submergence of northeastern Massachusetts and southeastern New Hampshire to a depth of at least 120 feet in the Merrimack estuary. This evidence is probably to be correlated with the evidence of submergence to a depth of 150 to 170 feet in the Piscataqua estuary, as recently worked out by Mr. Katz.

The mapping of the surface geology of the Groton quadrangle was continued during the field season by Prof. B. K. Emerson. During part of the time Prof. Emerson was in field conference with Mr. Keith and Mr. LaForge. Work on the revision of the texts and maps for the Fitchburg-Groton folio is well advanced toward completion. The text and maps for the Warwick-Winchendon folio are also well advanced. During April, May, and June Prof. Emerson was engaged in the preparation of a report on road materials of Massachusetts for the use of the War Department. Material for this report covering northeastern Massachusetts, was furnished by Mr. LaForge.

The areal and economic survey of the Greylock quadrangle was continued by L. M. Prindle, and several days were spent in reconnaissance studies in southwestern Massachusetts by Mr. Keith.

During parts of May and June examinations pertaining to the establishment of the Army camp at Ayer were made at the request of the United States Army officers by Mr. LaForge.

The text and maps for the Boston folio, by Mr. LaForge, are well advanced.

MICHIGAN.

A report on the gypsum deposits of Michigan has been prepared as a part of a bulletin by R. W. Stone on the gypsum deposits of the United States. Records of wells from which bromine is obtained in the Saginaw Valley and much general information concerning the bromine and chemical industries there were obtained by W. C. Phalen.

The manuscript of a report on the glacial moraines and shore lines of the Lake Superior region, by Frank Leverett, was well advanced toward completion.

A folio covering the Wayne, Detroit, Grosse Pointe, Romulus, and Wyandotte quadrangles has been issued as Folio 205.

MINNESOTA.

A report on the surface formations and agricultural conditions of northeastern Minnesota, by Frank Leverett and F. W. Sardeson, has been published as Bulletin 13 of the Minnesota Geological Survey. Proof of a similar report on the southern half of Minnesota, by Mr. Leverett and Mr. Sardeson, for publication by the Minnesota Geological Survey, has been read. These reports are products of the work done in cooperation between the Federal Survey and the Minnesota Geological Survey. They will be followed by a general report on the Quaternary geology of Minnesota by Mr. Leverett.

The glacial moraines and shore lines of the Lake Superior region are described by Mr. Leverett in a manuscript well advanced toward completion.

The cooperative study by this Survey and the State Survey of the iron ores of the Cuyuna range was continued by E. C. Harder as the Federal Survey's representative and A. W. Johnston for the State. One preliminary report, to be published by the State Survey, has been completed and is awaiting examination by the State geologist. Another, entitled "Notes on the geology and iron ores of the Cuyuna district, Minn.," with an outline map of the iron-bearing areas, has been published by this Survey as Bulletin 660–A. A paper on the geologic activity of iron bacteria in the precipitation of iron ores has been submitted by Mr. Harder, and a detailed report on the geology and ores of the Cuyuna range is in preparation.

MISSISSIPPI.

The geologic structure in the region between Vicksburg and Jackson, Miss., has been described by O. B. Hopkins in Bulletin 641–D, the demand for which was so great as to call for reprinting. Mr. Hopkins also made examinations of certain features near Biloxi thought by some to be indications of oil.

The Catahoula formation in the State is discussed by G. C. Matson in a paper entitled "The Catahoula sandstone," and by Prof. E. W. Berry in a paper entitled "The flora of the Catahoula sandstone," both in Professional Paper 98–M, and the Citronelle formation is discussed by Mr. Matson in a paper on "The Pliocene Citronelle formation of the Gulf Coastal Plain" (Professional Paper 98–L).

Reports on the stratigraphy of the Cretaceous deposits of Mississippi and on the ground waters of the northeastern part of the State, by L. W. Stephenson, were practically completed. Manuscripts on the Jackson formation and the Vicksburg group in Mississippi were submitted by C. Wythe Cooke, and a paper on the stratigraphy of the Upper Tertiary of Mississippi, by G. C. Matson, was completed. A report on the Pliocene history of northern and central Mississippi was completed by E. W. Shaw, and is in press as Professional Paper 108–H, and a paper by the same author on the Quaternary history of Mississippi, including an annotated bibliography, was begun. These papers will be published as parts of reports prepared in cooperation with the Mississippi State Geological Survey. The report on the general geology of the State will be published by the State Survey and the one on the ground waters of the State will be published by the Federal Survey.

A paper entitled "Geologic history indicated by the fossiliferous deposits of the Wilcox group (Eocene) at Meridian, Miss.," by E. W. Berry, was published as Professional Paper 108–E, and a monograph entitled "Later Eocene fossil plants of southeastern North America," also by E. W. Berry, transmitted for publication, contains descriptions of the later Eocene plants of the State. A "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, transmitted for publication, gives an account of the Eocene and lower Oligocene Bryozoa of Mississippi.

MISSOURI.

The study of the stratigraphy and paleontology of the Mississippian formations in southeastern Missouri has been continued by the State in cooperation with this Survey, these investigations being a part of a general plan organized and conducted in concert by the geologists of this part of the Mississippi Valley. A field conference touching a number of the local problems was in August held by representatives of several State surveys and of the Federal Survey.

The text and maps by F. C. Greene for a folio covering the Green City and Queen City quadrangles have been revised and are ready for publication.

The original edition of Bulletin 606, by C. E. Siebenthal, on the "Origin of the zinc and lead deposits of the Joplin region, Missouri, Kansas, and Oklahoma," having been exhausted, this paper has been reprinted.

MONTANA.

Two brief reports describing the Garnet and Dunkleberg districts, based on examinations made in the fall of 1915 by J. T. Pardee of mineral-bearing districts in northwestern Montana, are in press as Bulletins 660–F and 660–G, and others are in preparation.

The general geology and structure of an area embracing 750 square miles in Teton and Lewis and Clark counties were examined and classified with special reference to oil and gas possibilities by Eugene Stebinger, assisted by M. I. Goldman. A report by Mr. Stebinger under the title "Oil and gas geology of the Birch Creek–Sun River area, Mont.," has been transmitted for publication in "Contributions to economic geology, 1918, Part II" (Bulletin 691).

The somewhat complicated structure in a large area northwest of Billings embracing the Hailstone Basin was examined and mapped in detail by E. T. Hancock, who has submitted his classification and a report on the "Geology and oil and gas resources of the Lake Basin field" for publication in the same volume.

A part of the Musselshell Valley embracing 1,200 square miles was examined, classified, and mapped in detail by C. F. Bowen, with the object of obtaining data bearing upon its oil and gas possibilities. Mr. Bowen's report on "Anticlines in a part of the Musselshell Valley, Musselshell, Meagher, and Sweetgrass counties, Mont.," has been submitted for publication in Bulletin 691.

In northeastern Montana an area of about 6,912 square miles near Malta, including what is now known as the Bowdoin dome, was examined in rapid reconnaissance with classification of the lands, by A. J. Collier, whose report on the Bowdoin dome and its oil possibilities is in press as Bulletin 661–E.

A reconnaissance examination in the Yellowstone-Helena region, which includes the Gallatin and Madison national forests, with tracing of the phosphate horizon and the discovery of hitherto unreported beds of workable quality, was carried out by D. D. Condit, assisted by E. H. Finch. A portion of the report on this work has already been completed by Mr. Finch. Phosphate lands in Granite, Powell, and Deer Lodge counties were examined by J. T. Pardee.

The monograph on the "Geology of the Yellowstone Park," on which Arnold Hague had for many years been engaged and which will constitute his monumental work, was nearly complete at the time of Dr. Hague's death early in May.

A general reconnaissance study of the glacial and associated deposits in Sheridan, Valley, Phillips, and Blaine counties, and adjacent parts of Dawson County was made by W. C. Alden. A study of the literature of these and adjacent regions was made in the office, and a preliminary description was prepared by Mr. Alden.

NEBRASKA.

The more prominent anticlines of western Nebraska are described in a paper by N. H. Darton on the structure of parts of the central Great Plains submitted for publication in Bulletin 691.

The potash plant at Hoffland was examined by H. S. Gale.

NEVADA.

A detailed report on the geology and ore deposits of the Yerington district, Nev., has been submitted for publication as a professional paper by Adolph Knopf.

A report prepared by E. S. Bastin, in collaboration with F. B. Laney, of the Bureau of Mines, on the genesis of the ores of Tonopah, as interpreted from detailed microscopic studies of polished surfaces of the ores, is now in press as Professional Paper 104.

In addition to the report on the placers of Manhattan, H. G. Ferguson has in preparation as a professional paper a report on the geology and ore deposits of Manhattan and vicinity.

Late in the winter Adolph Knopf made a detailed geologic study of the Rochester district and a reconnaissance examination of the Arabia district. A report on the Arabia district is in preparation. A short paper on the ore deposits at Eureka is being prepared by G. F. Loughlin.

The results of an investigation of some of the gypsum deposits of the State by R. W. Stone will be found in a general description of the gypsum deposits of the United States, now ready for publication.

The oil-shale deposits of the Green River group in the vicinity of Elko, Nev., were examined by D. E. Winchester, whose descriptions, with accounts of tests, are contained in a paper now ready for submittal.

About a month was spent in Carson Sink by F. C. Schrader, completing a study of that region for an economic report on the ore deposits.

The following reports relating to mining districts in Nevada have appeared during the fiscal year:

Notes on some mining districts in eastern Nevada, by J. M. Hill (Bulletin 648).

The Golden Arrow, Clifford, and Ellendale districts, Nye County, Nev., by H. G. Ferguson (Bulletin 640–F).

Tin ore in northern Lander County, Nev., by Adolph Knopf (Bulletin 640–G).

Placer deposits of the Manhattan district, Nev., by H. G. Ferguson (Bulletin 640–J).

A paper by Mr. Knopf on "Wood tin in the Tertiary rhyolites of northern Nevada" has been transmitted for unofficial publication.

NEW HAMPSHIRE.

The raised Pleistocene shore lines in the Dover and York quadrangles, in Maine and New Hampshire, were specially studied by F. J. Katz. Reconnaissance studies in part of the Dover quadrangle, and practically all of the Berwick quadrangle were carried on by Mr. Katz, and a field conference was held by him with Arthur Keith and Laurence LaForge in the region about Rochester, N. H., and Berwick, Maine. Mr. LaForge spent two weeks in reconnaissance trips in southeastern New Hampshire and in reconnaissance mapping of Carboniferous stratified rocks west and northwest of Rochester, N. H.

A very brief reconnaissance in southwestern New Hampshire was made by Mr. Keith and a report on Pleistocene fossils from the Leda clays was made by W. H. Dall.

NEW JERSEY.

At the request of this Survey a digest of the ground waters of New Jersey was prepared, for the use of the War Department, by Dr. M. W. Twitchell, assistant State geologist, under instruction from Dr. H. B. Kümmel, State geologist.

The oil and gas explorations and the structural indications in the vicinity of Millville were examined by E. W. Shaw, at the request of the State Geological Survey.

The results of the analysis of greensands sampled at several points in the southern part of the State to show their possible value as sources of potash have been published in a report entitled "Notes on the greensand deposits of the eastern United States," by G. H. Ashley, published as Bulletin 660–B.

NEW MEXICO.

Field studies in the "Red Beds" region of New Mexico, with special reference to the history of their deposition and the possible presence of commercial amounts of potash salts associated with the thick deposits of salt and gypsum in the series, were continued by N. H. Darton, who is preparing a report on the region and its potash prospects. Exploratory examinations were made of 1,400 square miles, a reconnaissance examination of 820 square miles, and detailed mapping of 76 square miles. Mr. Darton also submitted a report on the gypsum deposits of New Mexico for incorporation in the general report on the gypsum deposits of the United States.

A deep well bored by a private company near Carlsbad was, through the courtesy of the company, visited by R. K. Bailey, who obtained therefrom a series of samples for testing with reference to their potash contents. Nothing of value was found, but as a depth of only 500 feet was attained, the salt beds of the region were not penetrated.

The geology of the Mogollon mining district was mapped in detail by H. G. Ferguson, who, in the fall of 1916, made a study of the ore deposits for a professional paper on that district. Mr. Ferguson also made a reconnaissance examination of the Steeple Rock district, and has in preparation a brief report thereon for inclusion in the annual economic bulletin.

Completion of the report on the copper deposits of the Burro Mountains (Tyrone district), by Sidney Paige, has been delayed by his assignment as geologist in charge of the section of western areal geology.

A detailed report on the copper deposits of the Santa Rita (Chino) district is in preparation by A. C. Spencer after an intermission caused by his assignment to work in Alaska.

Field work for a detailed study of the Magdalena or Kelly district has been completed by G. F. Loughlin. In connection with this investigation, some experimental work was carried out by Prof. W. O. Hotchkiss to determine the possible applicability of magnetic methods of surveying to ore deposits other than those of iron. Prof. Hotchkiss also extended his work to the Hanover and Santa Rita districts. The method was found to promise some usefulness in tracing concealed contacts between igneous and sedimentary rocks.

A paper entitled "A comparison of some Paleozoic sections in southern New Mexico," by N. H. Darton, has been issued as Professional Paper 108–C. Mesozoic invertebrates from the Magdalena limestone were studied by G. H. Girty, and Cretaceous invertebrates from southern New Mexico were reported on by T. W. Stanton, and from northwestern New Mexico by J. B. Reeside, jr.

As scientific by-products of the structural and land classification work in the coal-bearing region of northwestern New Mexico, by C. M. Bauer, J. B. Reeside, jr., and others, the following publications, under the general title "Contributions to the geology and paleontology of San Juan County," have been published as parts P, Q, R, and S, respectively, of Professional Paper 98:

Stratigraphy of a part of the Chaco River valley, by C. M. Bauer.

Vertebrate faunas of the Ojo Alamo, Kirtland, and Fruitland formations, by C. W. Gilmore.

Nonmarine Cretaceous invertebrates of the San Juan Basin, by T. W. Stanton.

Floras of the Fruitland and Kirtland formations, by F. H. Knowlton.

NEW YORK.

The areal and economic survey of the Berlin quadrangle, including a small part of Massachusetts, was continued by L. M. Prindle, who extended his geologic work into the adjacent Troy quadrangle. The folio covering the Berlin and Greylock quadrangles is nearing completion.

A study of the structure and succession of the rocks in the Hoosick and Cohoes quadrangles was made by Mr. Prindle. This areal work was reviewed by Arthur Keith, who also made a brief reconnaissance study of the formations in southeastern New York.

NORTH CAROLINA.

Feldspar deposits in the Spruce Pine district were examined by F. J. Katz in connection with his examination of the feldspar deposits of the Eastern States, the principal object of the work being to ascertain the possible value of the feldspars as sources of potash.

A report on the "Tin resources of the Kings Mountain district, N. C. and S. C.," by Arthur Keith and D. B. Sterrett, submitted early in the spring by Mr. Keith for use in "preparedness" work, is now in course of publication as Bulletin 660–D. In May and the early part of June H. G. Ferguson made special reconnaissance examinations of some of the North Carolina deposits and of those in Virginia (Irish Creek district), with reference to the possibility of their utilization for war purposes. Mr. Ferguson has begun the preparation of brief reports of the results of his work for publication in the annual "Contributions to economic geology."

The text and maps for the folio to cover the Kings Mountain and Gaffney quadrangles, the larger part of which lies in South Carolina, have been completed and submitted by Mr. Sterrett.

A digest of the ground waters of the Coastal Plain of North Carolina, for the use of the War Department, was prepared by L. W. Stephenson.

A comprehensive monograph entitled "The systematic paleontology of the Cretaceous deposits of North Carolina," prepared in cooperation between this Survey and the North Carolina Geological and Economic Survey, was transmitted to the State geologist for publication by the State Survey. This monograph included the following papers, some of which have been contributed by cooperating geologists and paleontologists:

General stratigraphic features of the Coastal Plain of North Carolina, by W. B. Clark.

Literature of the Cretaceous deposits of North Carolina, by L. W. Stephenson.

The faunas in their stratigraphic chronologic relations, by L. W. Stephenson.

The flora of the Black Creek formation, by E. W. Berry.

The correlation of the Cretaceous formations of North Carolina, by W. B. Clark.

Coelenterata, by L. W. Stephenson.

Echinodermata, by W. B. Clark.

Vermes, by L. W. Stephenson.

Mollusca, by L. W. Stephenson.

Arthropoda, by M. J. Rathbun.

Vertebrata (Reptilia), by C. W. Gilmore.

Plantae, by E. W. Berry.

A "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, transmitted for publication, contains descriptions of the Eocene Bryozoa of the State.

A report on the Tertiary corals of the southeastern part of the United States, including North Carolina, by T. W. Vaughan, is in progress.

NORTH DAKOTA.

A general reconnaissance study of the glacial deposits in Divide and Williams counties and adjacent part of Burke, Mountrail, and McKenzie counties, N. Dak., was made by W. C. Alden in July, 1916. The literature of this and adjacent regions was studied in the office, and a preliminary description was prepared. When returning from a western trip in August, 1916, Frank Leverett made a brief examination of the glacial drift in the vicinity of Bismarck.

The manuscript for the Edgeley-Lamoure folio, prepared under agreement by H. A. Hard, was revised somewhat by W. C. Alden.

The invertebrate fauna of the Cannonball member of the Lance formation is under investigation by T. W. Stanton.

OHIO.

In the course of the investigations of reported indications of potash samples of brine were obtained from oil wells in Monroe and Noble counties, Ohio, by W. C. Phalen for chemical analysis, and a reported occurrence of nitrate near Ashtabula was visited twice by H. S. Gale, who was present at the boring of a 25-foot hole in this neighborhood.

A detailed report on the geology and mineral resources of the Woodsfield and Summerfield quadrangles by D. D. Condit and R. V. A. Mills has been submitted for critical review. Two reports on the structure of the Berea sand, one (Bulletin 621-N) for the Summerfield quadrangle and the other (Bulletin 621-O) for the Woodsfield quadrangle, have been reprinted.

A report on the gas developments in and about Cleveland, by G. S. Rogers, has been issued as Bulletin 661-A.

The conditions of origin and deposition of the salts found in many wells and in pipe lines in the eastern portion of the State are the subject of a special investigation by R. V. A. Mills in association with R. C. Wells, of the division of chemistry and physics.

A folio describing the areal and economic geology of the Wellsville quadrangle and a bulletin on the structure and oil and gas resources of the quadrangle have been nearly completed, under agreement, by J. H. Hance. A folio text, covering the Steubenville and Cadiz quadrangles, by D. D. Condit, is ready for editing.

OKLAHOMA.

By courtesy of the Bureau of Mines a report by C. H. Beall, of that bureau, describing in detail the structure of the exposed rocks and of the individual oil sands, the relations of oil and gas to the structure, and the configuration of the salt-water surface in the Cushing field was cooperatively transmitted by Director Manning to the Geological Survey for publication. This paper, which is now in press, will appear as Bulletin 658.

The structure of the southern half of the Bristow quadrangle was examined in detail by A. E. Fath, and a report describing this area is now in preparation. A paper containing a description, with structure mapping, and a discussion of the oil and gas prospects of the north half of the same quadrangle is now in press as Bulletin 661-B.

Inspection of the general stratigraphy and criteria as to structure in Kingfisher County was made by Mr. Fath, who also examined and informally reported for the Office of Indian Affairs on a number of tracts of Indian land in the Iowa and Sac and Fox Indian reservations.

At the request of the superintendent of the Five Civilized Tribes and the Commissioner of Indian Affairs that the Survey furnish a geologist to make examinations of the structural conditions in certain Indian lands proposed for leasing, H. M. Robinson, associate geologist, was in March assigned to this duty.

During the summer of 1916 the structure of the northwest corner of the Pawhuska quadrangle, the areal geology of which had formerly been examined by C. D. Smith, who later resigned from the Survey, was mapped in detail by K. C. Heald, who during a part of the season was assisted by R. V. L. Stratton. A report on this area by Mr. Heald is in process of publication. Field work in the Pawhuska quadrangle was resumed in May by Mr. Heald, assisted by

K. C. Mather and, for the greater part of June, by D. E. Winchester and W. B. Emery, the investigation being carried on with the cooperation of the commissioner for the Osage Nation.

The structure and the oil and gas prospects in the Foraker quadrangle, in the Osage Nation, are described in a report by K. C. Heald, issued as Bulletin 641–B. This report has already been reprinted.

The structure of portions of the Hominy quadrangle was examined early in the winter by R. H. Wood, who in April resigned from the Survey with an agreement to complete at an early date his report on the structure and oil and gas prospects of the quadrangle. Information as to the structure in certain tracts of the Osage Nation offered for lease was furnished by Mr. Wood and Mr. Heald to the Office of Indian Affairs.

Data for the use of the Oklahoma Geological Survey in preparing a general geologic map of the State were cooperatively assembled under the supervision of Arthur Keith, chief of the section of eastern areal geology, who also furnished stratigraphic information to H. M. Robinson for his guidance in the land valuations for the Office of Indian Affairs.

Anticlines favorable for drill tests for oil and gas in Pontotoc County have been pointed out in a notice prepared by Mr. Robinson and distributed to the press by this Survey.

Examinations of the bituminous shales with sampling of coals were made by David White at a number of localities south of Muskogee and east of the Missouri, Kansas & Texas Railway, with the object of procuring additional criteria on which to base more definite conclusions as to the possible occurrence of oil in commercial amounts in the eastern part of the coal field and the southeastern part of the Paleozoic area of the State. Brief inspections were also made by Mr. White in the Bristow, Foraker, and Pawhuska quadrangles. in the Sac and Fox and Otoe Indian reservations, and at a number of points where drilling is now in progress in other parts of the State.

The two peneplains in western Arkansas were traced into the Lukfata quadrangle in the course of a reconnaissance by H. D. Miser.

Several deep wells in process of drilling were visited by R. K. Bailey, and arrangements were made for the collection of samples to be examined with reference to possible potash contents.

Collections of invertebrates from formations of Chester and Pottsville age were obtained by G. H. Girty, who also reported on other Carboniferous invertebrates from the State.

A report giving the results of a "Structural reconnaissance in the Okemah–Tiger Flats region, Okfuskee and Okmulgee counties," by A. E. Fath, has been submitted for publication in the "Contributions to economic geology." An anticlinal fold near Billings is mapped by Mr. Fath in Bulletin 641–E. The great demand for information egarding oil prospects in Oklahoma has necessitated republication f this report and of the reports by C. H. Wegemann on the Healdton ield (Bulletin 621-B) and on the Loco gas field, in Stephens and efferson counties (Bulletin 621-C).

OREGON.

A review of the nitrate prospects in southern Oregon, including the Sucker Creek claims, Buzzard Canyon, Stinking Lake, Rawhide, and Wagontire groups, was made by H. S. Gale.

A study of the chromite deposits of southwestern Oregon and an examination of the Great Gorge of the Columbia were carried on by J. S. Diller during a part of September.

Glacial deposits in the Cascade Mountains near Sisters, Oreg., were the subject of a reconnaissance by Frank Leverett.

PENNSYLVANIA.

The extramorainal glacial drift in parts of Lycoming, Clinton, Elk, and McKean counties was briefly studied by Frank Leverett in May.

The limestone formations of the Lebanon-Reading Valley, between the Mercersburg and Reading quadrangles, were mapped by G. W. Stose. A report giving the details of this examination is now in preparation by Mr. Stose.

The text and maps for the Fairfield-Gettysburg folio, by G. W. Stose and Florence Bascom, and for the Bellefonte folio, by Prof. E. S. Moore, have been completed and submitted for publication; and the text and maps for the Huntingdon and Hollidaysburg quadrangle have been revised by Charles Butts and the folio submitted.

A bulletin on the mineral resources of the Fairfield and Gettysburg quadrangles was prepared and submitted by Mr. Stose, and a report on the economic geology of the Allentown quadrangle, by B. L. Miller, is ready for editing.

The folio covering the Elkton and Wilmington quadrangles, by Florence Bascom and B. L. Miller, is in course of publication. These quadrangles also cover portions of Maryland and Delaware and were mapped in cooperation with the Maryland Geological Survey.

Some progress was made in field work in the McCalls Ferry and Quarryville quadrangles by E. F. Bliss and A. I. Jonas, and the text and maps for the Reading-Boyertown folio, by Florence Bascom, are nearly completed. In the Coatesville, West Chester, and Norristown quadrangles Miss Bascom was engaged in the further study of the various gneisses. Some reconnaissance work was done by Arthur Keith in southeastern Pennsylvania.

A general description of the bituminous coal fields of the State, with analyses and quantitative estimates of the coal resources in the beds and areas, by G. H. Ashley, is at an advanced stage of completion as a chapter of Professional Paper 100. A similar treatment of the anthracite fields and coals to go in the same volume is in preparation by Baird Halberstadt. Both papers are to be accompanied by maps.

Economic bulletins and folios covering the mineral resources and the general geology of the Punxsutawney, Curwensville, and Houtzdale quadrangles have been nearly completed by Mr. Ashley.

The detailed areal and structural examination of the Butler quadrangle was completed by G. B. Richardson and R. V. A. Mills, and the greater part of the Zelienople quadrangle was mapped in the season of 1916. The field studies of the Zelienople quadrangle were completed by Mr. Richardson in the spring of 1917, special attention being given to the composition and history of the waters locally found in the oil sands of the region. Mr. Richardson submitted in April an estimate of the petroleum resources remaining in the ground in western Pennsylvania.

The publication of the report on the geology of the Johnstown and Somerset quadrangles by Mr. Richardson has been delayed, pending the solution of certain problems concerning the correlations and formational boundaries as drawn in Maryland, southern Pennsylvania, and eastern Ohio. Paleontologic data on the Brush Creek coal and limestone and criteria for the determination of the Allegheny-Conemaugh boundary in the quadrangles above mentioned and in western Maryland were obtained in June, 1917, by Harvey Bassler, assisted by T. E. Williard.

The stratigraphy and fossils of the formations of central Pennsylvania were studied by E. O. Ulrich and Charles Butts in the valley region in June.

RHODE ISLAND.

The field examinations of the Cretaceous and Pleistocene deposits of the islands off the Rhode Island coast were completed by Prof. J. B. Woodworth, who, in accordance with an agreement, is engaged in the preparation of a report on the areal geology, history, and water resources of the Coastal Plain areas of southern New England.

SOUTH CAROLINA.

An investigation of the stratigraphy, structure, and ground waters of the Coastal Plain of South Carolina was begun by C. W. Cooke, who prepared, for the use of the War Department, a digest of available information on the ground waters of the State.

A "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, transmitted for publication, contains descriptions of fossil Bryozoa from South Carolina.

The maps and manuscript for a folio on the Kings Mountain and Gaffney quadrangles, which include a small portion of North Carolina, have been completed by D. B. Sterrett and submitted for publication.

SOUTH DAKOTA.

An inspection of the structural criteria and of the gas developments in the Missouri Valley in the neighborhood of Pierre, S. Dak., was made late in the autumn by E. T. Hancock, with a view to determining whether geologic structure of types favorable for the occurrence of oil or gas was present or could be recognized if present.

A report describing and mapping the lignite field of northwestern South Dakota, by D. E. Winchester, C. J. Hares, E. R. Lloyd, and E. M. Parks, has been published as Bulletin 627.

TENNESSEE.

Field and office work for a report on the marbles of Tennessee, to be incorporated in a general report on the marbles of the Southern States, was carried on by T. N. Dale.

Greensands in McNairy County, in western Tennessee, were sampled by G. H. Ashley for the purpose of obtaining more authentic information as to their value as sources of potash. The results are given in Bulletin 660–B.

The preparation of the folio covering the Waynesboro quadrangle, by H. D. Miser, has advanced somewhat, but on account of the demands on Mr. Miser's time for the preparation of reports on the geology and mineral resources of portions of Arkansas, this folio is not yet completed.

At the request of the State geologist of Tennessee, A. H. Purdue, arrangements were made for the transfer of Mr. Miser's office work to Nashville during June, in order that he might attend to the duties of the State geologist during Mr. Purdue's enforced absence for a time on account of his health.

The text and maps for a report on the coal resources of the Crossville quadrangle were revised by Charles Butts, who has submitted a short paper on the coals between Clifty and Bon Air that has been issued as Bulletin 641–K.

A comprehensive report on the Ducktown district awaits portions of the description of the general geology, by Arthur Keith and F. B. Laney.

TEXAS.

Drilling at Cliffside, Tex., for the purpose of procuring adequate information as to the reported presence of potash in the region west of Amarillo was resumed as soon as the necessary equipment and crew could be obtained. This well, which had reached a depth of about 360 feet before work had been suspended the preceding year on account of exhaustion of funds, has now reached a depth of 1,657 feet. No potash in notable amount has yet been found there.

The sulphur deposits of eastern Texas were examined by P. S. Smith with special reference to the question of drawing on them as sources of raw material for the manufacture of sulphuric acid.

Digests of the ground waters of the Coastal Plain of Texas, for the use of the War Department, were prepared by C. W. Cooke and T. W. Vaughan. A report on the ground waters of the Coastal Plain of Texas west of Brazos River, by Alexander Deussen, is in progress. A preliminary report on the stratigraphy, structure, and correlation of the Cretaceous deposits of northeastern Texas, by L. W. Stephenson, is nearly complete.

The Catahoula formation is discussed by G. C. Matson in a paper entitled "The Catahoula sandstone," and by Prof. E. W. Berry in a paper entitled "The flora of the Catahoula sandstone," both in Professional Paper 98–M, and the Citronelle formation is discussed by Mr. Matson in a paper on "The Pliocene Citronelle formation of the Gulf Coastal Plain" (Professional Paper 98–L).

A monograph entitled "Later Eocene fossil plants of southeastern North America," by E. W. Berry, transmitted for publication, contains descriptions of fossil plants from Texas, and a "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, also transmitted for publication, gives accounts of fossil Bryozoa from the State.

Examinations of oil indications reported as present at a number of points in the Coastal Plain region of Texas were made by O. B. Hopkins, who paid special attention to the domes near Brenham and Palestine and has described these domes in a paper now in press as Bulletin 661–G. A report on the geologic structure and conditions of oil distribution in the Corsicana-Powell district, by G. C. Matson and O. B. Hopkins, is nearly ready to be issued as Bulletin 661–F.

Late in the spring of 1917 a somewhat exhaustive study of the salt domes of the Coastal Plain of the State, with special reference to the origin and conditions of occurrence of the salt, sulphur, oil, and gas in the domes, was begun by G. S. Rogers.

A second edition of Bulletin 629, "Natural-gas resources of parts of north Texas," by E. W. Shaw and G. C. Matson, has been issued and exhausted.

Large collections of early Paleozoic invertebrates, submitted by the Texas Bureau of Economic Geology and Technology, under the direction of J. A. Udden, were studied by E. O. Ulrich.

UTAH.

The Little Cottonwood and American Fork districts, Utah, were examined during the field season of 1916 by B. S. Butler, assisted by F. F. Hintze, and will be the subjects of a detailed report. A comprehensive report on the ore deposits of Utah by Mr. Butler and G. F. Loughlin is in preparation. A report on zinc carbonate and related copper carbonate ores at Ophir, by G. F. Loughlin, is to be published as Bulletin 690–A.

Reported deposits of molybdenum ore in the vicinity of Ouray were examined by F. L. Hess in May, 1917.

Two reports describing the location and conditions of occurrence of phosphate in the Logan quadrangle have been completed and transmitted by E. H. Finch.

Examinations for the recovery of potash at several points in the region of Salt Lake City were made by H. S. Gale. The report giving the potash content of some Utah copper ores (Bulletin 620–J) has been reprinted.

The oil shales in the Green River formation of the Uinta Basin were traced westward from Dragon by D. E. Winchester, who demonstrated the presence of a large body of productive shale in the western portion of the basin. The results of the work are given in a paper on " Oil shale in the Uinta Basin, Utah," now ready for publication as a part of Bulletin 691. Mr. Winchester also examined and sampled the oil shales at Ephraim and at several other points in the State.

A second issue of Bulletin 641–A, " Ozokerite in central Utah," by H. M. Robinson, has been necessary.

Cambrian and Devonian invertebrates from the Wasatch Range were studied by Edwin Kirk. Reports were made on Carboniferous invertebrates from a number of localities by G. H. Girty, and on fossil plants by F. H. Knowlton.

A description of the Lost Creek coal field, in Morgan County, by F. R. Clark, is ready for editing.

VERMONT.

The areal survey of the Bennington quadrangle was continued by L. M. Prindle. This quadrangle, combined with the Hoosic quadrangle (New York), will be covered by a folio, for which the text and maps are nearly completed.

The pre-Cambrian granites and gneisses and their structure in the Rutland, Wallingford, and Castleton quadrangles were further studied and mapped in detail by Arthur Keith, who gave special attention also to the deformed shore lines in these quadrangles. A paper on these shore lines was given by him at the Albany meeting of the Geological Society of America.

VIRGINIA.

In order to ascertain more fully the physiographic and stratigraphic conditions under which the manganese deposits of the valley region of Virginia were laid down and later to test the applicability of the tentative hypothesis previously adopted by D. F. Hewett to the discovery of new ore bodies, the central part of the valley, including several mines, was in June visited by Arthur Keith, Dr. T. L. Watson, State geologist, M. R. Campbell, D. F. Hewett, G. W. Stose, Laurence LaForge, F. J. Katz, and J. B. Umpleby and a trial made. The examination and description of the manganese mines and prospects of the State is nearly completed by Dr. Watson, and the results of the Virginia manganese investigations will be published under cooperative auspices.

The tin deposits in the Irish Creek district were studied by H. G. Ferguson in the spring of 1917, and a report giving the results is in preparation.

An experimental plant near Yorktown for the extraction of potash from greensand was early in June inspected by H. S. Gale, A. C. Spencer, and W. B. Hicks, in company with H. M. Ami, of the British Embassy, for the purpose of viewing a working test of the plant.

The areal mapping of the coal field in the western part of the State and of Buchanan County in particular was continued cooperatively by Henry Hinds, of this Survey, assisted by T. K. Harnsberger for the State. A report on the geology and coal resources of Buchanan County is nearly completed, the geologic map being ready for transmission to the State for publication. A report on Carboniferous invertebrates was made by G. H. Girty.

A chapter on the Coastal Plain of Virginia, to form a part of a geographic manual on the northern Middle Atlantic States, was prepared by L. W. Stephenson.

A digest of the ground waters of the Coastal Plain of Virginia, for the use of the War Department, was prepared by L. W. Stephenson.

WASHINGTON.

A description of the geographic features of the Mount Rainier National Park and their origin has been revised by F. E. Matthes for publication on the back of the topographic map covering the park.

lacial deposits near Spokane, Puget Sound, and Mount Rainier studied for a few days by Frank Leverett.

report covering a "Reconnaissance of the Conconully and Ruby ing districts, Wash.," by E. L. Jones, has been issued as Bulle- 540–B.

vertebrate fossils from the Tertiary formations of the western of the State are under investigation by W. H. Dall.

WEST VIRGINIA.

n the search for a very pure glass sand such as is needed for the nufacture of optical instruments to be used by the Army and vy, the sandstone deposits in the vicinity of Berkeley Springs were mined by R. W. Stone in company with H. S. Washington, who resented the Carnegie Geophysical Laboratory.

Office work on the maps and description of the Williamsport quadngle, which includes parts of Maryland and Pennsylvania, has been vanced by G. W. Stose. This material will form part of the Wilmsport-Hagerstown folio, and the work is being done in cooperan with the State of Maryland.

WISCONSIN.

The text and maps for a folio covering the Wausau and Marathon adrangles, studied in cooperation with the State Geological and atural History Survey, have been completed by Samuel Weidman nd the folio submitted for publication.

A report on the glacial moraines and shore lines of the Lake Suerior region, by Frank Leverett, is nearing completion. In connecion with the preparation of this paper some field work was done n October and a field conference was had by Mr. Leverett with Dr. Weidman. "The Quaternary geology of southeastern Wisconsin," y W. C. Alden (Professional Paper 106), is now in press.

Early Paleozoic formations in parts of the State were studied by E. O. Ulrich in cooperation with State Geologist Hotchkiss for the purpose of ascertaining the equivalents of some of the Wisconsin geologic formations as compared with those of New York, Alabama, and other areas.

WYOMING.

At the request of the National Museum lithologic collections were made in the Leucite Hills, Wyo., by E. S. Larsen.

The report on the geologic structure and oil resources of the southern portion of the Big Horn Basin, by D. F. Hewett and C. T. Lupton, has been revised and brought up to date, following further field examinations made by Mr. Hewett in October, and the report is now in press as Bulletin 656.

A report on the structure and oil prospects of the Elk Basin was prepared and submitted for publication by C. J. Hares, and a report covering the Salt Creek district, by C. H. Wegemann, has been submitted and is now in process of publication as Bulletin 670. "Anticlines in central Wyoming," by C. J. Hares, has been published and reprinted as Bulletin 641–I.

Cretaceous invertebrates from the Big Horn Basin and from eastern Wyoming were reported on by T. W. Stanton, and Mesozoic invertebrates from Carbon County were identified by J. B. Reeside, jr.

A comprehensive study of American Jurassic ammonites belonging to the family Cardioceratidae, mostly from Wyoming, was made and the first draft of a paper on them was prepared by J. B. Reeside, jr.

Carboniferous invertebrates were reported on by G. H. Girty, and the study and description of the fauna of the Big Horn limestone were continued by Edwin Kirk.

The stratigraphy of the Wind River Mountains is the subject of a paper by Eliot Blackwelder, now ready for publication as a bulletin.

A report on the "Relations of the Embar and Chugwater formations in central Wyoming," by D. D. Condit, was published as Professional Paper 98–O, and a paper by C. H. Wegemann on "Wasatch fossils in so-called Fort Union beds in the Powder River basin, Wyo.," has been issued as Professional Paper 108–D.

The gypsum deposits in the southern part of the Big Horn Mountains are described by C. T. Lupton and D. D. Condit in Bulletin 640–H.

CANAL ZONE AND WEST INDIES.

The following monographs prepared in compliance with an agreement made in 1912 between the Canal Commission, the United States Geological Survey, and the Smithsonian Institution have been transmitted to the Secretary of the Smithsonian Institution for publication:

Introduction to Contributions to the geology and paleontology of the Canal Zone, Panama, and geologically related areas in Central America and the West Indies, by T. W. Vaughan.

On some fossil and recent Lithothamnieae of the Panama Canal Zone, by M. A. Howe, with plates 1–11.

The fossil higher plants from the Panama Canal Zone, by E. W. Berry, with plates 12–18.

The smaller fossil Foraminifera of the Panama Canal Zone, by J. A. Cushman, with plates 19–33.

The larger fossil Foraminifera of the Panama Canal Zone, by J. A. Cushman, with plates 34–45.

Fossil Echini of the Panama Canal Zone and Costa Rica, by R. T. Jackson, with plates 46–52 and text figures 1–8.

Fossil Bryozoa of the Panama Canal Zone and Costa Rica, by F. Canu and R. S. Bassler, with plate 53.

Crustacea and Decapoda from the Panaman region, by M. J. Rathbun, with plates 54-66.

Cirripedia from the Panama Canal Zone, by H. A. Pilsbry, with plate 67.

The following papers also are nearly ready for transmission:

Fossil Madreporaria from Panama and geologically related areas in Central America and the West Indies, with about 70 plates, by T. W. Vaughan.

The stratigraphic relations and biologic character of the serimentary formations of the Panama Canal Zone and geologically related areas in Central America, by T. W. Vaughan and D. F. MacDonald, with two maps and several text figures.

Correlation of the sedimentary geologic formations of Panama in their relation to the geologic history of Central America and the West Indies, by T. W. Vaughan.

Prior to his resignation from the United States Geological Survey, D. F. MacDonald completed an extensive monograph on the physiography, stratigraphy, geologic history, and economic geology of the Canal Zone. This paper will be submitted to the Smithsonian Institution for publication as soon as information procured through the paleontologic investigations can be incorporated in it.

As paleontologic studies collateral to those of the Tertiary formations of the southeastern United States and the Canal Zone, J. A. Cushman has monographically described collections of fossil Foraminifera from the Leeward Islands, the Dominican Republic, and Jamaica and nearly finished a similar account of collections from Cuba. T. W. Vaughan has nearly finished a general monograph of the fossil corals of the West Indies; all material in the United States National Museum, except a few species from the islands of Antigua and Anguilla, has been described and figured.

Other similar faunal monographs for the West Indies, mostly by specialists not connected with the Survey, are either complete or almost complete. These careful, comprehensive investigations of the stratigraphic paleontology of the West Indies furnish a basis for accurate stratigraphic work in that area. As the United States has so many interests in the West Indies, the results obtained through the investigations mentioned are of particular importance.

DIVISION OF ALASKAN MINERAL RESOURCES.

APPROPRIATION AND CLASSES OF WORK.

Under the appropriation of $100,000 made for the continuation of the investigation of the mineral resources of Alaska, as in previous years, work of the following classes was carried on: Reconnaissance and detailed geologic surveys, special investigations of mineral resources, reconnaissance and detailed topographic surveys, investigations of water resources, and collection of statistics of mineral production.

PERSONNEL.

On July 1, 1916, the personnel of the division consisted of 1 geologist in charge, 11 geologists, 4 topographic engineers, 1 hydraulic engineer, 3 clerks, and 1 draftsman on annual salaries, 1 field assistant, and 31 camp hands and recorders. On June 30, 1917, the personnel included 1 acting geologist in charge, 9 geologists, 1 topographic engineer, 1 hydraulic engineer, 3 clerks, and 1 draftsman on annual salaries, and 1 clerk on per diem salary. The field force also included 6 camp hands and recorders.

The following members of the division of Alaskan mineral resources received commissions on or prior to June 30, 1917:

Alfred H. Brooks, major, Engineer Officers' Reserve Corps.
J. W. Bagley, captain, Engineer Officers' Reserve Corps.
E. M. Aten, captain, Quartermaster's Department.
C. E. Giffin, captain, Engineer Officers' Reserve Corps.

FIELD WORK DURING THE SEASON OF 1916.

Areas covered and allotments.—Twelve parties were engaged during 1916 in Alaska surveys and investigations. Of these parties seven were engaged in geologic surveys, three in topographic surveys, one was a combined topographic and geologic party, and one was engaged in stream gaging. The areas covered by geologic reconnaissance surveys on a scale of 1:250,000 (4 miles to an inch) amount to 5,100 square miles; by detailed geologic surveys on a scale of 1:62,500 (1 mile to an inch), 636 square miles. The results of investigation of special problems relating to mineral occurrence can not be expressed areally. About 9,700 square miles of topographic reconnaissance surveys on a scale of 1:250,000 (4 miles to the inch) and 65 square miles on a scale of 1:62,500 (1 mile to an inch) were made. In cooperation with the Forest Service, stream gaging in southeastern Alaska was also continued.

With increased knowledge of Alaska's geology and the new facts made available by mining operations, it has become necessary to revise some of the previous interpretations of the geology, especially those made before accurate base maps were available. Therefore, the revision of some of the mapping of the earlier years becomes of vital importance, and to this work some time is devoted each year. In 1917 an area of 36 square miles adjacent to Juneau, previously surveyed geologically on a scale of 1:62,500, was mapped on the larger scale of 1:24,000. The geologic mapping of about 1,500 square miles on a scale of 1:250,000 was also revised.

To state the work geographically, four parties worked in southeastern Alaska, one in the Copper River region, two on Prince William Sound, and four in the Yukon basin, and one was engaged in general investigations in the Yukon basin and Seward Peninsula. Among the important results of the year were the completion of the detailed topographic and geologic survey of Juneau and vicinity; the completion of the reconnaissance geologic survey of the southern part of the Ketchikan district, and the detailed survey of a part of the Nenana coal field.

The following tables show the allotments, including both field and office work, of the total appropriation of $100,000 for the fiscal year 1916 to the regions investigated. In addition to this a balance of about $6,000 from last year's appropriation was expended in equipping parties for the season's field work. General office expenses are apportioned to the several allotments. Salaries of the permanent staff are included up to the close of the fiscal year 1917, but expenses other than these include only the cost of field and office work during 1916. The "general investigations" include, among other things, the cost of collecting mineral statistics and of office work relating to the field investigations of previous seasons. A balance of about $6,000 has been utilized for equipping field parties in 1917.

Approximate geographic distribution of appropriation for Alaska investigations, 1916–17.

Southeastern Alaska	$22, 500
Copper River	7, 000
Prince William Sound	14, 500
Yukon basin	42, 500
Seward Peninsula	1, 000
General investigations	6, 500
Allotted to field work, 1917	6, 000
	100, 000

Approximate allotments to different kinds of surveys and investigations, 1916–17.

Geologic reconnaissance surveys	$15, 000
Detailed geologic surveys	20, 000
Special geologic investigations	11, 600
Reconnaissance topographic surveys	19, 000
Detailed topographic surveys	4, 500
Water resource investigations	4, 900
Collection of mineral statistics	1, 600
Miscellaneous, including administration, inspection, clerical salaries, office supplies and equipment, and map compilation	17, 400
Allotted to field work, 1917	6, 000
	100, 000

Allotments for salaries and field expenses, 1916–17.

Scientific and technical salaries	$39,843
Field expenses	37,615
Clerical and office salaries	16,542
Allotted to field work, 1917	6,000
	100,000

The following table exhibits the progress of investigations in Alaska and the annual grant of funds since systematic surveys were begun in 1898. It should be noted that a varying amount is spent each year on special investigations that yield results which can not be expressed in terms of area.

Progress of surveys in Alaska, 1898–1916.

Year.	Appropriation.	Areas covered by geologic surveys.			Areas covered by topographic surveys.[a]					Investigations of water resources (gaging stations maintained part of year).
		Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000).	Detailed (scale 1:62,500).	Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000; 200-foot contours).	Detailed (scale 1:62,500 and larger; 25, 50, or 100 foot contours).	Lines of levels.	Bench marks set.	
		Sq. m.	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Miles.*		
1898	$46,189	9,500	....	....	12,840	2,070	....	....	....	....
1899	25,000	6,000	....	....	8,690	....	....	....	....	....
1900	60,000	3,300	6,700	....	630	11,150	....	....	....	....
1901	60,000	6,200	5,800	....	10,200	5,450	....	....	....	....
1902	60,000	6,950	10,050	....	8,330	11,970	96	....	....	....
1903	60,000	5,000	8,000	96	....	15,000	....	....	....	....
1904	60,000	4,050	3,500	....	800	6,480	480	86	19	....
1905	80,000	4,000	4,100	536	....	4,880	787	202	28	....
1906	80,000	5,000	4,000	421	....	13,500	40	....	....	14
1907	80,000	2,600	1,400	442	....	6,120	501	95	16	45
1908	80,000	2,000	2,850	604	....	3,980	427	76	9	53
1909	90,000	6,100	5,500	450	6,190	5,170	444	....	....	81
1910	90,000	....	8,635	321	....	13,815	36	....	....	[illegible]
1911	100,000	8,000	10,550	496	....	14,460	246	....	....	68
1912	90,000	....	2,000	525	....	....	298	....	....	69
1913	100,000	3,500	2,950	180	3,400	2,535	287	....	....	....
1914	100,000	1,000	7,700	325	600	10,300	10	....	....	....
1915	100,000	....	10,700	200	....	10,400	12	3	2	9
1916	100,000	....	5,100	636	....	9,700	67	....	....	30
	1,461,189	73,200	99,535	5,232	51,680	146,980	3,731	453	74	....
Percentage of total area of Alaska	....	12.48	16.80	0.89	8.81	25.05	0.64	....	....	....

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[a] The Coast and Geodetic Survey, International Boundary Survey, and General Land Office have also made topographic surveys in Alaska. The areas covered by these surveys are, of course, not included in these totals.

General work.—Alfred H. Brooks, geologist in charge, was engaged in office work until July 24, when he started for Alaska. He joined Mr. Chapin at Ketchikan on August 2 and devoted the next two weeks to the study of the geology of the Ketchikan district. The time from August 19 to 26 was spent in the Juneau district with Mr. Spencer and Mr. Eakin. Here a conference was also had with

Mr. Canfield. A study of the geology of the Latouche district of Prince William Sound was made in company with Mr. Johnson from August 30 to September 10. A brief visit was then made to Anchorage, and several more days were spent at Juneau on the return trip. Seattle was reached on September 24.

In the office Mr. Brooks devoted 56 days to geologic studies, 24 days to the critical reading and revision of manuscripts, 13 days to the writing of the progress report, 10 days to field plans, 8 days to mineral statistics, 5 days to proof reading, and 4 days to preparation of the annual press bulletin on mining in Alaska. Mr. Brooks was absent from the office the month of June and part of May, and during this time G. C. Martin was engaged chiefly in executive work as acting geologist in charge of the division.

R. H. Sargent continued the general supervision of the Alaska topographic surveys and map compilation, in addition to carrying on his own field work, until May 26, when he went to Peking on furlough to act as professor of surveying triangulation in the Government Institute of Military Survey of China. Mr. Sargent's administrative duties were then assigned to Mr. Bagley and Mr. Witherspoon.

During the last six years J. W. Bagley has been investigating the use of photographic methods in Alaska topographic surveys. In this work he has devised both methods and instruments, whose utility has been proved by actual use. During 1916 he prepared a report on the results of this work, which has been published as Bulletin 657.

Arthur Hollick was employed for one month in writing the description of the Cretaceous and Tertiary floras of Alaska.

E. M. Aten continued as office assistant to the geologist in charge and supervised the office work during Mr. Brooks's absence in the field. He also continued to assist in collecting statistics of production of precious metals in Alaska.

Southeastern Alaska.—The geologic reconnaissance survey of the southern half of the Ketchikan district, begun in 1913 and continued in 1915, was completed in 1916. These investigations were made by Theodore Chapin, who devoted the time between May 20 and September 20 to the work. In addition to revising the previous geologic map an area of some 500 square miles was surveyed on a reconnaissance scale. Considerable time was also devoted to a study of the ore deposits and an investigation of mining developments.

The making of a detailed base map of the region adjacent to Juneau, which was begun in 1914, was completed in 1916. The large scale adopted, 1:24,000 (2.64 inches to the mile), and the ruggedness of the region, together with heavy timber and adverse climatic conditions, have made this survey exceedingly difficult and expensive.

The area covered is 36 square miles, of which 12½ square miles was surveyed in 1916. Owing to the high cost of the survey it has been necessary to confine it to those areas which are of greatest present economic importance. D. C. Witherspoon, who did this work, was engaged in field work from May 29 to September 27, inclusive.

The area covered by the base map above referred to was surveyed geologically during 1916 by A. C. Spencer and H. M. Eakin, who also made a detailed investigation of the ore deposits. Field work was begun on July 11 and continued until October 6, covering an area of 36 square miles. Mr. Eakin also devoted about three weeks to a study of the Porcupine placer district. This district had not been investigated by a geologist since 1903, during which time some developments had been made. Mr. Eakin also devoted about a week to collecting data on mining developments in the more isolated parts of the Juneau district.

The investigation of the water resources of southeastern Alaska, begun in 1915 under a cooperative agreement with the Forest Service, was continued throughout 1916. G. H. Canfield, who had charge of this work, maintained 8 automatic gages throughout the year. In addition, 12 other gages were installed in cooperation with various individuals and corporations. This work could not have been carried on without the cordial cooperation of the Forest Service. Many members of that service have given substantial aid, but particular acknowledgment should be made to W. G. Weigle, special agent at Ketchikan, and to Leonard Lundgren, district engineer at Portland, Oreg.

Copper River region.—Though much the larger part of the Chitina basin has been covered by geologic surveys, there are still many unsolved problems relating to the stratigraphy, structure, and ore deposits. These can be solved only by a more or less intensive study of special areas, and to this task F. H. Moffit was assigned. He devoted the time from June 23 to September 29 to this work. In addition to making a special study he also made geologic reconnaissance surveys of about 300 square miles.

Prince William Sound.—The rapid development of mining in the Prince William Sound region has made a demand for further surveys and investigations. During 1916 B. L. Johnson made a somewhat detailed survey of the Latouche district, in which he covered an area of about 400 square miles. In addition to this he made some investigations of the mining developments in other parts of the Prince William Sound region. Mr. Johnson devoted the time from June 11 to October 18 to this work.

J. W. Bagley began topographic reconnaissance surveys in the Port Wells district of the Prince William Sound region on June 8 and extended these surveys eastward, continuing his field work until Sepember 12. He covered an area of 1,900 square miles on a scale of 1:250,000, using photographic methods. In addition he surveyed in detail (scale 1:62,500) an area of 65 square miles lying adjacent to Jack Bay, this work connecting the previously mapped areas of the Ellamar and Port Valdez districts.

Yukon basin.—G. C. Martin, assisted by A. G. Maddren and R. M. Overbeck, made a detailed geologic study of the western part of the Nenana coal field. The base map was provided for this work by the surveys made by the General Land Office. The field work was begun on June 16 and continued to August 24, and the total area surveyed was 236 square miles on a scale of 1:62,500.

S. R. Capps and C. E. Giffin were charged with the duty of making a reconnaissance survey of the Kantishna placer district. The surveys were begun on Nenana River and extended westward to include the Kantishna district and southward to the crest line of the Alaska Range. Mr. Capps, who had charge of the geologic investigations, began work on June 26 and continued until August 25, surveying an area of about 1,000 square miles on a scale of 1:250,000. He also revised previous geologic mapping over an area of about 2,000 square miles. Mr. Giffin, who made the topographic survey, began field work on June 26 and completed it on August 29. He covered an area of 4,500 square miles, using photographic methods.

The important developments in the Tolovana district led to an investigation of this field during 1916. J. B. Mertie, jr., was detailed for this work and began field work in the Tolovana district on July 7, continuing until August 4. Besides studying the placers he made a geologic reconnaissance map of about 240 square miles. The time from August 8 to 31 was devoted by Mr. Mertie to an investigation of the ore deposits of the Fairbanks district. In this field he devoted special attention to the occurrence of tungsten.

Important mining developments in the Marshall district of the lower Yukon have made an urgent demand for a survey of this field. Therefore a combined geologic and topographic party under the direction of R. H. Sargent, with G. L. Harrington as geologist, was assigned to this field. This party began work on June 16 and continued until September 6. The topographic and geologic surveys cover an area of some 3,300 square miles.

Seward Peninsula.—J. B. Mertie, jr., was detailed to make a supplementary investigation of the lodes in the Nome and other districts of Seward Peninsula. He devoted the time from September 19 to October 13 to this work and paid special heed to the tungsten and antimony deposits. In addition he collected data on mining developments.

FIELD WORK FOR THE SEASON OF 1917.

Field work was begun before the end of the fiscal year (during June) by four parties, as indicated below. S. R. Capps began the investigation of the mineral resources of the region tributary to that part of the Government railroad under construction, lying between Anchorage and Broad Pass, except the Matanuska coal field and the Yentna placer district. G. L. Harrington began the examination of the reported occurrences of platinum in the Tolstoi region of the Innoko district, the Dime Creek region of the Koyuk district, and the Bear Creek region of the Fairhaven district. A. G. Maddren started for southwestern Alaska to investigate the sulphur deposits on Unalaska Island and the beach placers near Red River, on the west shore of Kodiak Island, which are reported to carry platinum. Time permitting, he will also investigate the recent lode mining developments on Unga Island and the occurrence of sulphur on Makushin Volcano. D. C. Witherspoon began a topographic reconnaissance survey (scale, 1:250,000) of the region adjacent to or accessible from tidewater of that part of Prince William Sound extending from Point Whitehead, south of Cordova, northward to the Ellamar district. G. H. Canfield from January throughout the year has continued the investigation of the water powers of southeastern Alaska in cooperation with the Forest Service. All these surveys and investigations will continue into the fiscal year 1917–18.

COLLECTION OF STATISTICS.

The collection of the statistics of production of precious metals in Alaska, begun by the Alaska division in 1905, was continued as usual. Preliminary estimates of mineral production for 1916 were published on January 1, 1917. The progress report for 1916 (Bulletin 662–A), containing the full statement and tables on mineral production, was transmitted on May 5, 1917.

PUBLICATIONS.

During the year the Survey published six bulletins (Nos. 630, 631, 642, 649, 657, and 666–P) and one water-supply paper (No. 382) relating to Alaska. Two topographic maps (Pl. I, Bulletin 630, and Pl. I, Bulletin 631) were published during the year.

Three bulletins (Nos. 655, 662, and 666–P), one water-supply paper (No. 418), and three topographic maps (lower Matanuska Valley, by R. H. Sargent, scale 1:62,500, contour interval 50 feet; Juneau and vicinity, by D. C. Witherspoon, scale 1:24,000, contour interval 50 feet; and Lake Clark-central Kuskokwim, by R. H. Sargent, scale 1:250,000, contour interval 200 feet) were in press at the end of the year.

Manuscripts of the following reports are completed:

The Canning River region, northern Alaska, by E. de K. Leffingwell (Professional Paper 109).

The Cosna-Nowitna region, Alaska, by H. M. Eakin (Bulletin 667).

The Nelchina-Susitna region, Alaska, by Theodore Chapin (Bulletin 668).

The upper Chitina Valley, Alaska, by F. H. Moffit (Bulletin 675).

The marble resources of southeastern Alaska, by E. F. Burchard.

The Kantishna region, Alaska, by S. R. Capps.

The Anvik-Andreafski region, including the Marshall district, Alaska, by G. L. Harrington.

The following reports are in hand:

The lower Kuskokwim region, by A. G. Maddren.

The Kotsina-Kuskulana district, by F. H. Moffit.

The upper Matanuska basin, by G. C. Martin.

Geology of the Glacier Bay and Lituya region, Alaska, by F. E. Wright and C. W. Wright.

Geology of the region along the international boundary from Porcupine River to the Arctic Ocean, by A. G. Maddren.

The Yakataga district, by A. G. Maddren.

The Mesozoic stratigraphy of Alaska, by G. C. Martin.

The Valdez district, by B. L. Johnson.

The Ruby-Kuskokwim region, by J. B. Mertie, jr., and G. L. Harrington.

The Cretaceous and Tertiary floras of Alaska, by Arthur Hollick.

The Nenana coal field, by G. C. Martin.

The Porcupine district, by H. M. Eakin.

The Ketchikan district, by Theodore Chapin.

The structure and stratigraphy of Gravina and Revillagigedo islands, by Theodore Chapin.

The geology of Latouche Island, by B. L. Johnson.

Office work on the 12 maps listed below has been completed:

Kotsina-Kuskulana district, by D. C. Withersoon; scale, 1:62,500; contour interval, 100 feet.

Nelchina-Susitna region, by J. W. Bagley; scale, 1:250,000; contour interval, 200 feet.

Juneau and vicinity, by D. C. Witherspoon; scale, 1:24,000; contour interval, 50 feet.

Lower Kuskokwim region, by A. G. Maddren; scale, 1:500,000; contour interval, 400 feet.

Cosna-Nowitna region, by H. M. Eakin; scale, 1:250,000; contour interval, 200 feet.

Ruby district, by C. E. Giffin and R. H. Sargent; scale, 1:250,000; contour interval, 200 feet.

Lower Yukon region, by R. H. Sargent; scale, 1:250,000; contour interval, 100 feet.

Marshall district, by R. H. Sargent; scale, 1:250,000; contour interval, 100 feet.

Canning River region, by E. de K. Leffingwell; scale, 1:250,000; sketch contours.

North Arctic coast, by E. de K. Leffingwell; scale, 1:500,000; no contours.

Martin Point to Challenge Entrance, by E. de K. Leffingwell; scale 1:125,000; no fixed contour interval.

Challenge Entrance to Thetis Island, by E. de K. Leffingwell; scale, 1:125,000; no fixed contour interval.

The following topographic maps are in hand:

Innoko-Iditarod region, by R. H. Sargent and C. E. Giffin; scale, 1:250,000; contour interval, 200 feet.

Anchorage-Matanuska region, by R. H. Sargent and others; scale, 1:250,000; contour interval, 200 feet. (This includes maps of the "Matanuska region" and "Turnagain-Knik region," which were previously reported separately.)

Yukon-Tanana Valley; compiled; scale, 1:500,000; contour interval, 400 feet.

Glacier Bay region; compiled; scale, 1:250,000; contour interval, 200 feet.

Kantishna region, by C. E. Giffin; scale, 1:250,000; contour interval, 200 feet.

Port Wells region, by J. W. Bagley; scale, 1:250,000; contour interval, 200 feet.

Jack Bay district, by J. W. Bagley; scale, 1:62,500; contour interval, 50 feet.

Upper Chitina Valley, by F. H. Moffit; scale, 1:250,000; contour interval, 200 feet.

SCIENTIFIC RESULTS.

Each of the geologists who has been at work in Alaska during the year has, as in previous years, added greatly to the volume of knowledge concerning the geology of that Territory. It is not possible to enumerate here all the important discoveries that have been made, but those of widest interest or of most far-reaching importance will be mentioned.

In southeastern Alaska Upper Triassic fossils were discovered by A. C. Spencer and H. M. Eakin in a series of slates and andesites of the Juneau district. This not only adds a new Triassic locality to those previously known in Alaska but gives new and very important evidence concerning the age of the metamorphic rocks of this district. This does not mean, however, that the slates of southeastern Alaska are all Triassic, for there has also been a new discovery, by Theodore Chapin, of Jurassic or Cretaceous fossils in the slate and graywacke of Gravina Island, which have previously been tentatively assigned by some to the Triassic and by others to the Paleozoic. Mr. Chapin has also determined that the structure of the Ketchikan district is that of a syncline overturned toward the southwest and has discovered important lower Carboniferous fossil localities on the west coast of Prince of Wales Island. Mr. Eakin determined that both the original and the secondary structural features in the Funter Bay district dip at low angles. This structure has, apparently, an important influence on the ore deposits, as it caused the ore-bearing solutions to form large fissure veins instead of the more diffused stockworks of the areas of nearly vertical dip. Valuable information concerning the extent of the Quaternary submergence was obtained by A. C. Spencer and H. M. Eakin, who found marine fossils and beach lines at an elevation of 600 feet in the vicinity of Juneau—nearly twice as high as they had previously been known at this locality—and by Theodore Chapin, who found marine fossils at an elevation of 80 feet on Gravina Island. Mr. Eakin found evidence in the Porcupine district of two distinct ice advances, each followed by intrenchment of hanging valleys and by concentration of placer gold deposits.

The investigation of the copper deposits of Prince William Sound by B. L. Johnson revealed the fact that chalmersite ($CuFe_2S_3$), a mineral previously known only as small crystals from South America and not as an ore, occurs as an abundant constituent of the copper ores at several of the prospects on Knight Island.

In the Copper River region F. H. Moffit obtained collections of fossils which seem to indicate that the Kennicott formation may be Cretaceous instead of Upper Jurassic, as has been hitherto supposed.

In the Yukon Valley J. B. Mertie, jr., discovered an important and previously unrecognized chert formation, possibly several thousand feet thick, of Devonian or Carboniferous age, in the Tolovana district. S. R. Capps, working in the Kantishna district, on the north front of the Alaska Range, obtained evidence indicating that the Cantwell formation is considerably older than the Tertiary coal-bearing rocks and is possibly separated from those rocks by a significant unconformity. The Cantwell formation and the Tertiary coal-bearing rocks have been supposed to be of the same age, as they both apparently carry the Kenai flora. G. C. Martin, A. G. Maddren, and R. M. Overbeck, working in the Nenana coal field, discovered that the burning of the coal beds, which is still in progress, began during or before Pleistocene time. The Pleistocene gravels contain abundant worn fragments of burned shale and clinker derived from the burned Tertiary coal beds. This fact proves that these gravels, previously referred tentatively to the Tertiary, are separated from the Tertiary coal-bearing strata by an unconformity, and it affords a criterion for the recognition of the younger gravels, which in obscure outcrops can not otherwise be readily distinguished from the gravel members of the Tertiary beds. Mr. Mertie discovered that in the Fairbanks district and also on Seward Peninsula the tungsten and gold mineralization were apparently independent of each other.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

In the chemical laboratory 265 quantitative analyses and 1,490 qualitative determinations of rocks and minerals were reported during the year, the samples tested consisting chiefly of minerals sent in for inspection.

F. W. Clarke, in cooperation with W. C. Wheeler, completed for publication Professional Paper 102, "The inorganic constituents of marine invertebrates." He also published papers entitled "The constitution of melilite and gehlenite" and "Geochemical evidence as to early forms of life." The work on marine invertebrates is being extended still further. At its centennial celebration, in January, the

Russian Mineralogical Society elected Mr. Clarke an honorary member.

George Steiger, in cooperation with Dr. T. L. Watson, State geologist of Virginia, published a note on the effect of manganese on the coloration of amethyst and rose quartz. In cooperation with E. S. Larsen he published "Mineralogic notes." Mr. Steiger had charge of the administrative work of the division and also during the winter and spring he devoted much time to drawing plans, making estimates, and moving the laboratory to the new building.

W. T. Schaller continued his work on a number of unfinished manuscripts, prepared for the division of mineral resources reports on mica, precious stones, lithium, thorium, zirconium, and rare-earth minerals, published papers on the two new minerals crandallite and magnesioludwigite, and continued his study of uranium and vanadium minerals. An investigation of a water-soluble blue molybdenum mineral from Utah showed it to be ilsemannite, which was proved to be a sulphate of molybdenum. Mr. Schaller also prepared an exhibition of specimens in the National Museum illustrating the occurrence and association of the gem tourmalines of southern California and undertook a field investigation of the deposits of phlogopite mica in the United States. Much of Mr. Schaller's time was taken up with routine mineralogic and chemical investigations.

Experimental work on several problems involving physical chemistry was carried on by R. C. Wells. In addition to analyzing a number of rocks from Panama, including some that have been involved in the slides, Mr. Wells found that these rocks are particularly susceptible to the moisture conditions of the atmosphere and that they gain and lose weight in definite dependence on the humidity of the air. These results were transmitted to Mr. D. F. MacDonald, the geologist investigating the slides, in a report "The variable water content of certain rocks from Panama." In cooperation with R. V. A. Mills, Mr. Wells has begun a new line of study of oil-field waters with reference to their evaporation and concentration by natural gases. This work, which is nearly completed, has included analyses of waters, evaporation crusts, and rocks and the determination of the solubility of certain compounds under the special conditions involved, as well as a study of the water content of natural gases and the relative amounts of gas and water and of salts dissolved in water present in oil-field sands. Mr. Wells prepared a paper "On the solubility of calcite in sea water in contact with the atmosphere, and its variation with temperature," to be published in a Carnegie Institution publication with papers by T. W. Vaughan and others on similar subjects, and a report on "New determinations of carbon dioxide in water of the Gulf of Mexico," to be published in the Survey's "Shorter contributions to general geology." In cooperation with E. S. Larsen, Mr. Wells published a paper on "Lorettoite, a new mineral." His routine analytical work included analyses of six pegmatites, two platinum ores, a chromite, four lead ores, five iron ores, and two so-called "paraffin earths."

W. B. Hicks devoted nearly all of his time to routine work, consisting mainly of the analyses of miscellaneous samples, including glauconite and brines, with special reference to their potash content. In conjunction with Mr. Bailey he described a new method for determining potash in glauconite, which has been published as a part of G. H. Ashley's report on greensands (Bulletin 660–B).

R. K. Bailey was engaged in routine work from July to October in connection with the Survey's potash investigation. Since October, 1916, he has been at Cliffside, Tex., where the Survey is drilling a well in search for potash, and has been testing the samples as they come from this and other wells. He has also visited other drilling operations in the vicinity and collected samples and well records.

Chase Palmer devoted a large part of his time to routine work, consisting of miscellaneous chemical analyses of rocks, minerals, oil shales, brines, oil-field waters, and distillates from oil shales. He was also occupied with research on the relations of oil-field waters from California. During the year he published in Economic Geology an article called "Diarsenides as silver precipitants." The conduct of several arsenical minerals has been determined, and their capacities as precipitants of metallic silver have been measured. The chemical nature of iron in the mineral löllingite has also been determined. A reagent by which the proportion of a simple arsenide may be determined in mineral mixtures containing also arsenosulphides and bisulphides is given in the article. The chemical facts which have been thus learned afford a rational explanation of the replacement deposits of metallic silver in the rich silver district of Cobalt, Ontario.

In the physical laboratory the investigations noted in previous reports have been continued under the direction of C. E. Van Orstrand. Considerable time has been given to an extension of the paper on earth temperatures. Temperature measurements were made in six wells of exceptional depth in the vicinity of Clarksburg, W. Va. A. F. Melcher made a number of determinations of the porosity of oil and gas bearing sands and devoted considerable time to the preparation of a paper dealing with the subject. He also assisted R. V. A. Mills in conducting an experiment on the migration of natural oil in certain sands.

In addition to his administrative work as chief of the division G. F. Becker has been occupied mainly in studies of capillarity and heat conduction from the geologist's point of view. His paper on "Mechanics of the Panama Canal slides" appeared as Professional Paper 98–N.

During the fiscal year a total of 1,231 letters were written in the division, of which 868 were numbered letters and 363 were for the signature of members of the division.

DIVISION OF MINERAL RESOURCES.

The Survey has continued its policy of making the annual report "Mineral Resources of the United States" more than a statistical compilation by recording and interpreting industrial progress and especially by treating in full the sources from which the mineral products of the country are obtained. This report is an annual inventory of the Nation's mineral resources.

During the last 14 years the separate chapters have been prepared in large part by geologists of the Survey who have specialized in the respective subjects treated, with a view to carrying out the provision of the organic act of the Survey which directs the examination of the mineral resources and products of the national domain.

Cooperation between the Geological Survey and the State surveys in collecting most of the mineral statistics continued in force in the preparation of the report for 1916. The 15 States that cooperated were Alabama, Florida, Illinois, Iowa, Maryland, Michigan, Minnesota, Missouri, New Jersey, New York, North Carolina, Oregon, Virginia, Washington, and Wisconsin. By this cooperation duplication of a considerable amount of work is obviated, and the producers are saved the annoyance of preparing two sets of statistical returns. On June 30, 1917, the manuscripts of 11 chapters for the report for 1916 had been completed and transmitted to the printer.

The entrance of this country into the war has served to increase the demand for information concerning our mineral resources, and as a result a bulletin entitled "Our mineral supplies," supplementing Bulletin 599, "Our mineral reserves," is being prepared. This bulletin reviews in a brief way the condition of the mineral industry with reference to its ability to supply the many and varied demands caused by war. Thirty chapters of this bulletin have been prepared during the year. The Council of National Defense was furnished a complete set of manuscript statements for every mineral of importance, showing production, imports, consumption, and sources of supply, with diagrams. This information was furnished promptly—within two or three days after being called for—and represented in tabloid form the up to the minute data available through the division of mineral resources. Through its committees the council has also called upon the Geological Survey for more detailed information concerning mineral resources. An increased demand has been made for information concerning the basic mineral resource—coal. The publication of monthly statements of shipments of coal was begun during the year. This information was of much value to the coal ommittee of the Council of National Defense, but the call for more etailed information as to mine capacity, shipping facilities, etc., ould be supplied only by enlarging the scope of the inquiry carried n by the Geological Survey. To accomplish this end the force was emporarily increased by the addition of five employees, and the ublication of weekly statements of coal shipments was also begun.

The Tariff Commission also availed itself of the information at and in the Geological Survey and called for a statement of conensed figures and data concerning nearly every mineral. This nformation also was furnished promptly. All these inquiries and he preparation of Bulletin 666 have been undertaken with comparaively little increase of force, causing, however, some delay in the ublication of the annual report.

In response to a general demand for prompt and impartial staistics relating to the broader phases of the petroleum industry, the ivision began the collection and publication of monthly statistics howing the quantity of crude oil moved from field sources, the uantity delivered to refiners or to consumers, and the quantity in torage at the end of each month for each of the major fields of oil production east of the Rocky Mountains. These summaries are necessarily incomplete, for owing to the magnitude of this great industry in the United States complete statistics of production can be obtained but once a year, and even then require at least six months for their collection and compilation. The monthly statements, which include comparative statistics for the current month, the month immediately preceding, and the corresponding month in 1916, are compiled from reports submitted voluntarily by about 200 pipe-line and refining companies and furnish a valuable and timely index to the status of the industry in each field, accounting for between 90 and 95 per cent of the crude oil marketed each month in the area designated.

Preliminary estimates of output in 1916 were issued in December, 1916, or January, 1917, with reviews of the conditions that prevailed during the year, in the form of special press bulletins on the following subjects: Bauxite and aluminum; cement; chromite; coal; coke; copper, gold, and silver (general); gold and silver in Alaska; iron ore; lead; lime; mineral products; petroleum; potash; quicksilver; sulphur; zinc; and metal production in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, and Washington (mine reports). Advance statements giving the final figures for the production of copper, lead, and other substances in 1916 have also been published.

The employees who devote their entire time to the work of the division in Washington number 36, and 8 are stationed in the field offices at Salt Lake City, Denver, and San Francisco. In addition to these, 24 specialists give part of their time to the work of the division, making a total of 68 persons.

During the year 217,986 pieces of first-class mail matter were sent out by the division and 77,315 pieces were received.

H. D. McCaskey continued as geologist in charge of the division, in charge of the metals section, and of the three offices of the division in the Western States; E. F. Burchard was geologist in charge of the nonmetals section of the division during the year and continued as an author of several chapters of Mineral Resources of the United States; and G. F. Loughlin has been designated as geologist acting in charge of the nonmetals section of the division to assist him. Owing to the death of R. B. Dole the preparation of the report on mineral waters has been assigned to O. E. Meinzer, of the water-resources branch. E. S. Bastin, who has been on leave of absence, has been succeeded by H. G. Ferguson in the preparation of the report on graphite. The reports formerly prepared by W. C. Phalen, who has been transferred to the Bureau of Mines, have been assigned to other geologists already on the staff of the division, except that on sulphur and pyrite, which has been assigned to P. S. Smith.

The reports on the several mineral products were prepared by the following persons:

Authors of chapters in Mineral Resources.

Author.	Subject.
A. H. Brooks	Gold, silver, and copper in Alaska.
E. F. Burchard	Cement; fluorspar and cryolite; iron ore, pig iron, and steel.
B. S. Butler	Copper (general report); copper and silver in Michigan (mines report).
Martha B. Clark	Mineral products of United States (summary) (with H. D. McCaskey).
J. S. Diller	Asbestos; chromite; talc and soapstone.
J. P. Dunlop	Silver, copper, lead, and zinc in the Central States, except Michigan (mines report); secondary metals; metals and ores (summary report); gold and silver (general report) (with H. D. McCaskey).
H. G. Ferguson	Graphite.
H. S. Gale	Borax; magnesite (with C. G. Yale); nitrates.
C. N. Gerry	Gold, silver, copper, lead, and zinc in Idaho and Washington (mines reports).
V. C. Heikes	Gold, silver, copper, lead, and zinc in Arizona, Montana, Nevada, and Utah (mines reports).
C. W. Henderson	Gold, silver, copper, lead, and zinc in Colorado, New Mexico, South Dakota, Texas, and Wyoming (mines reports).
F. L. Hess	Antimony, arsenic, bismuth, cobalt, molybdenum, nickel, selenium, tantalum, tungsten, titanium, vanadium, uranium, tin.
D. F. Hewett	Manganese and manganiferous ores.
J. M. Hill	Aluminum and bauxite; barytes; mineral paints; platinum and allied metals; strontium ore; gold, silver, copper, lead, and zinc in the Eastern States (mines report).
F. J. Katz	Abrasives; feldspar; silica (quartz).
C. E. Lesher	Coal; fuel briquetting; the manufacture of coke.
G. F. Loughlin	Building stone; lime; slate.
H. D. McCaskey	Gold and silver (general report) (with J. P. Dunlop); mineral products of the United States (summary report) (with Martha B. Clark); quicksilver.
O. E. Meinzer	Mineral waters.
Jefferson Middleton	Clay-working industries; fuller's earth; sand-lime brick.
J. D. Northrop	Asphalt and bituminous rock; natural gas; petroleum.
C. E. Siebenthal	Lead; zinc and cadmium (general reports).
W. T. Schaller	Gems and precious stones; mica.
P. S. Smith	Sulphur and pyrite.
R. W. Stone	Gypsum; phosphate rock; sand and gravel; salt, bromine, and calcium chloride.
J. S. Turp	Peat.
C. G. Yale	Borax; magnesite (with H. S. Gale); gold, silver, copper, lead, and zinc in California and Oregon (mines report).

The offices of the division at Denver, Salt Lake City, and San ancisco are under direct charge of C. W. Henderson, V. C. Heikes, d C. G. Yale, respectively, who prepare the mine reports on gold, ver, copper, lead, and zinc in the Western States. They also act cooperation with other members of the Survey where necessary, th in the field and in the office, and by keeping in close touch with e mining regions of the West they procure and disseminate much luable information not readily obtained otherwise. These offices e, therefore, general Survey headquarters and bureaus of informa- on in their respective regions. The Denver office, at 409 New Post ffice Building, prepares the metal-mine reports for South Dakota, yoming, Colorado, and New Mexico; the Salt Lake City office, at 12 Post Office Building, covers in the same way the States of Mon- na, Idaho, Washington, Utah, Nevada, and Arizona; and the San rancisco office, at 305 Customhouse, is the headquarters for Califor- ia and Oregon.

TOPOGRAPHIC BRANCH.

ORGANIZATION.

The organization of the topographic branch is as follows:

Chief geographer, R. B. Marshall.
Atlantic division, Frank Sutton, geographer, in charge.
Central division, W. H. Herron, geographer, in charge.
Rocky Mountain division, C. H. Birdseye, topographic engineer, in charge.
Northwestern division, T. G. Gerdine, geographer, in charge.
Pacific division, G. R. Davis, geographer, in charge.
Division of military surveys, Glenn S. Smith, topographic engineer, in charge.
Inspector of topography, J. H. Renshawe, geographer; W. M. Beaman and A. M. Walker, topographic engineers.

PERSONNEL.

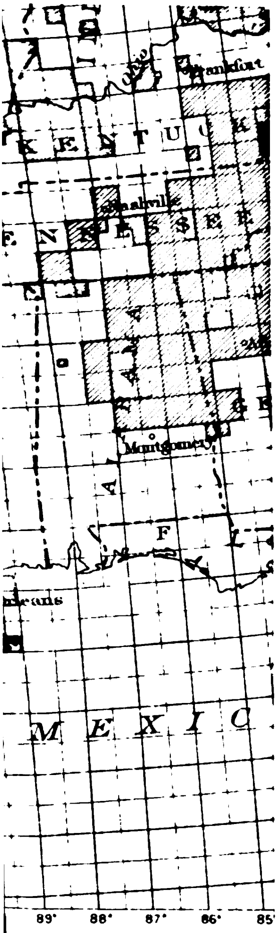
The technical corps of the topographic branch was increased during the year by the reinstatement of two topographic engineers and one junior topographer and by the appointment of 14 junior topographers and the transfer of 1 draftsman, and was reduced 16 by death and resignations. With those changes the corps now includes 1 chief geographer, 8 geographers, 38 topographic engineers, 17 topographers, 41 assistant topographers, 44 junior topographers, and 6 draftsmen—a total of 155. In addition, 40 technical field assistants were employed during the whole or a part of the field season. One topographer, 1 assistant topographer, and 6 junior topographers are on furlough. The clerical force comprises 11 clerks of various grades.

The following members of the topographic branch received co missions in the Engineer Officers' Reserve Corps on or prior June 30, 1917:

Maj. W. M. Beaman.
Maj. R. H. Chapman.
Maj. W. H. Griffin.
Maj. G. T. Hawkins.
Maj. W. H. Herron.
Maj. J. H. Jennings.
Maj. R. B. Marshall.
Maj. Robert Muldrow.
Maj. A. C. Roberts.
Maj. G. S. Smith.
Maj. Frank Sutton.
Maj. A. M. Walker.
Maj. J. H. Wheat.
Capt. R. W. Berry.
Capt. C. H. Birdseye.
Capt. Basil Duke.
Capt. A. T. Fowler.
Capt. C. E. Giffin.
Capt. Duncan Hannegan.
Capt. H. H. Hodgeson.
Capt. E. I. Ireland.
Capt. B. A. Jenkins.
Capt. C. B. Kendall.
Capt. E. L. McNair.
Capt. W. L. Miller.
Capt. Albert Pike.
Capt. C. L. Sadler.
Capt. A. B. Searle.
Capt. J. G. Staack.
Capt. W. O. Tufts.
First Lieut. J. E. Blackburn.
First Lieut. A. O. Burkland.
First Lieut. J. R. Eakin.
First Lieut. R. T. Evans.
First Lieut. S. P. Floore.
First Lieut. R. A. Kiger.
First Lieut. E. L. Hain.
First Lieut. L. L. Lee.
First Lieut. L. S. Leopold.
First Lieut. T. H. Moncure.
First Lieut. W. H. S. Morey.
First Lieut. O. H. Nelson.
First Lieut. A. J. Ogle.
First Lieut. S. T. Penick.
First Lieut. T. F. Slaughter.
Second Lieut. S. H. Birdseye.
Second Lieut. D. S. Birkett.
Second Lieut. E. C. Burt.
Second Lieut. Howard Clark.
Second Lieut. F. A. Danforth.
Second Lieut. C. H. Davey.
Second Lieut. W. S. Gehres.
Second Lieut. W. F. Hicks.
Second Lieut. R. M. Herrington.
Second Lieut. J. B. Leavitt.
Second Lieut. Kostka Mudd.
Second Lieut. J. M. Rawls.
Second Lieut. L. B. Roberts.
Second Lieut. M. A. Roudabush.
Second Lieut. O. G. Taylor.
Second Lieut. J. H. Wilson.

PUBLICATIONS.

The published work of the topographic branch for the fiscal y consists of 85 published maps and 7 bulletins, giving results of spi leveling in Arkansas, Georgia, Mississippi, North Carolina, N Mexico, South Dakota, and Texas. Brief summaries of the bo publications (Bulletins 635, 636, 637, 638, 639, 643, and 646) are giv on pages 20, 23 and 24. The remaining 16 parts of Bulletin 6 "Triangulation and primary traverse in the United States, 191 1915," were published separately and were also combined with t two parts previously published and issued in one volume. A n edition of "Geographic tables and formulas" (Bulletin 650) was p lished, and the report on spirit leveling in Ohio (Bulletin 651) w practically ready for distribution at the end of the fiscal year. Ma script for the results of leveling in Nevada, New York, Illin Kentucky, and Washington was transmitted for publication.



URVEYS PRIOR

ALLOTMENTS.

The total appropriations for topographic surveys for the fiscal year 1917 were:

Topographic surveys	$350,000
Surveying national forests	75,000
Statutory salaries	9,200
Special military maps	35,000
	469,200

Allotments of these appropriations were made as follows:

Allotments from funds appropriated for topographic work, fiscal year 1917.

	Topographic surveys, statutory salaries, and special military maps.	Surveying national forests.
General administration	$26,798	$5,250
Clerical assistance and supervision	15,040	3,080
Map editing	3,436	704
Purchase and repair of instruments, stationery, etc	34,426	3,466
Millionth-scale map	20,000	…………
Work by land-classification board	9,000	2,500
Field work:		
Atlantic division	58,000	…………
Atlantic division, special military maps	35,000	…………
Central division	45,000	…………
Rocky Mountain division	60,000	16,000
Northwestern division	40,000	25,500
Pacific division	47,500	18,500
	394,200	75,000

COOPERATION.

Cooperation has been maintained in 16 States, which contributed the following amounts:

California	$14,000.00	New York	$10,000.00
California, special river surveys	1,000.00	Oregon	1,000.00
Illinois	9,000.00	Texas	9,636.07
Iowa	1,750.00	Vermont	2,500.00
Kentucky	10,000.00	Virginia	4,500.00
Maine	5,000.00	Washington	11,500.00
Michigan	15,000.00	West Virginia	4,304.62
Minnesota	4,250.00	Wisconsin	3,000.00
Missouri [1]	3,000.00		109,440.69

SUMMARY OF RESULTS.

The condition of topographic surveys to June 30, 1917, distinguished as to scale, etc., is shown on Plate II.

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[1] Agreement was entered into, but the State money did not become available until after the Federal funds were diverted to military mapping.

As shown in the following tables, the total new area mapped was 20,103 square miles, making the total area surveyed to date in the United States 1,257,623 square miles, or 41.5 per cent of the entire country. In addition, 2,377 square miles of resurvey was completed, making the total area of surveys during the year 22,480 square miles.

In connection with these surveys, 6,190 linear miles of primary levels were run, making 266,011 miles of primary and precise levels run since the authorization of this work by Congress in 1896. In the course of this work 1,512 permanent bench marks were established. In addition, 208 linear miles of river surveys were run.

Triangulation stations to the number of 243 were occupied and 203 were permanently marked. Primary traverse lines aggregating 4,058 miles were run, in connection with which 358 permanent marks were set.

The area covered by topographic surveys in Alaska during the fiscal year, as reported in detail on pages 82–87, was 9,765 square miles.

Present condition of topographic surveys of the United States and new area surveyed July 1, 1916, to June 30, 1917.

	New area mapped July 1, 1916, to June 30, 1917.	Total area mapped to June 30, 1917.	Percentage of total area of State mapped to June 30, 1917.
	Sq. mi.	*Sq. mi.*	
Alabama	....	19,192	37
Arizona	594	70,136	62
Arkansas	....	21,494	40
California	2,648	119,618	76
Colorado	530	50,980	49
Connecticut	....	4,965	100
Delaware	534	1,736	73
District of Columbia	....	70	100
Florida	1,016	3,355	6
Georgia	1,320	18,907	32
Idaho	942	28,196	33
Illinois	702	15,946	28
Indiana	....	3,609	10
Iowa	151	11,916	21
Kansas	....	64,159	78
Kentucky	80	18,094	45
Louisiana	....	8,306	17
Maine	210	9,975	30
Maryland	....	12,327	100
Massachusetts	....	8,266	100
Michigan	1,103	8,198	14
Minnesota	389	7,354	9
Mississippi	....	2,126	4
Missouri	188	36,913	53
Montana	722	58,511	40
Nebraska	65	26,817	35
Nevada	26	51,141	46
New Hampshire	99	3,479	37
New Jersey	....	8,224	100
New Mexico	1,469	40,049	33
New York	304	44,663	91
North Carolina	....	18,390	35
North Dakota	....	9,814	14
Ohio	....	41,040	100
Oklahoma	57	39,908	57
Oregon	259	24,663	26
Pennsylvania	228	25,136	56
Rhode Island	....	1,248	100
South Carolina	....	5,640	18
South Dakota	139	19,082	25
Tennessee	....	21,283	50

Present condition of topographic surveys of the United States and new area surveyed July 1, 1916, to June 30, 1917—Continued.

	New area mapped July 1, 1916, to June 30, 1917.	Total area mapped to June 30, 1917.	Percentage of total area of State mapped to June 30, 1917.
	Sq. mi.	*Sq. mi.*	
Texas	1,676	70,976	27
Utah	228	69,025	82
Vermont	67	4,473	47
Virginia	2,004	31,984	75
Washington	1,579	29,325	42
West Virginia	....	24,170	100
Wisconsin	90	12,692	23
Wyoming	684	30,043	31
Total, United States	20,103	1,257,623	41.5
Hawaii	1,393	....	....

SPECIAL MILITARY SURVEYS.

Summary.—The special appropriation of $35,000 which was made by Congress for the War Department for the topographic survey of such areas as it might select was allotted to the Geological Survey and devoted entirely to mapping in Virginia. This work in Virginia was continued and the mapping of other areas was commenced after March 26, under the arrangement that the total available balance of funds in the topographic branch should be used in making maps to meet the urgent needs of the War Department. Under this arrangement surveys were commenced in New Hampshire, Delaware, and Pennsylvania under the direction of Mr. Sutton; in Georgia and Florida under the direction of Mr. Herron; in Texas under the direction of Mr. Birdseye; and in Arizona and New Mexico under the direction of Mr. Gerdine; while in California the mapping in progress at the request of the War Department was continued and that of new areas was undertaken under the direction of Mr. Davis. The mapping of this class accomplished before the end of the fiscal year amounted to —— square miles, and the results are given below by States.

Arizona.—The survey of the United States portion of the Perilla quadrangle, lying partly in the Chiricahua National Forest, in Cochise County, Ariz., and Grant County, N. Mex., was completed by J. E. Blackburn and Cornelius Schnurr, the area mapped being 223 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 13 square miles is within the national forest.

California.—The survey of the Piedras Blancas, Point Sur, and Posts quadrangles, lying partly in the Monterey National Forest, in Monterey and San Luis Obispo counties, was completed, and that of the Jamesburg, Lucia, King City, Junipero Serra, Metz, Gonzales, San Simeon, Gorda, Bryson, Adelaida, and San Miguel quadrangles, lying partly in the Monterey National Forest, in Monterey, San Benito, and San Luis Obispo counties, was begun by T. P. Pendleton, C. A. Stonesifer, W. B. Upton, jr., N. E. Ballmer, E. G. Hamilton, William Stranahan, C. R. Fisher, Roscoe Reeves, R. C. Seitz, K. W. Trimble, C. P. McKinley, C. A. Ecklund, J. P. Harrison, R. M. Wilson, E. P. Davis, Charles Hartmann, R. T. Evans, W. G. Carson, C. W. H. Nessler, Bruce Jameyson, E. T. Walker, and Fred Rider, the total area mapped being 1,057 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. Of this area 153 square miles is included within the national forest. For the control of these areas and of the San Benito, Bonanza, and Hollister quadrangles, in the same counties, R. C. Seitz and L. F. Biggs ran 594 miles of primary levels and established 129 permanent bench marks, and C. F. Urquhart and Mr. Biggs occupied 42 triangulation stations and marked 21. In addition, 79 miles of primary levels were run, and 12 permanent bench marks were set to close other level circuits. In connection with the mapping of the Adelaida and San Miguel quadrangles, Mr. Upton made a plan and profile survey of portions of Salinas, Nacimiento, and San Antonio rivers, the distance traversed being 48 linear miles, for publication on the scale of 1:48,000.

Delaware.—The survey of the Millsboro quadrangle, in Sussex County, was completed, and that of the Harrington, Cedar Creek, and Cape Henlopen quadrangles, in Sussex and Kent counties, was begun by W. H. Griffin, F. W. Crisp, R. A. Kiger, S. P. Floore, A. B. Searle, C. E. Cooke, A. P. Meade, L. B. Glasgow, J. F. McBeth, and J. H. Wilson, the total area mapped being 543 square miles, for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet. This work includes 9 square miles of resurvey in Caroline County, Md. For the control of these areas Mr. Wilson ran 123 miles of primary traverse and set 8 permanent bench marks, and S. H. Birdseye ran 129 miles of primary levels and established 22 permanent bench marks.

Florida.—The survey of the Lawtey quadrangle, in Baker and Bradford counties, was completed, and that of the Middleburg, Maclenny, Orange Park, Cambon, Jacksonville, Palm Valley, Fernandina, and Mayport quadrangles, in Duval, Baker, Nassau, St. Johns, and Clay counties, was begun by J. H. Jennings, Gilbert Young, Fred Graff, jr., M. A. Roudabush, C. L. Sadler, O. G. Taylor, R. M. Harrington, W. L. Miller, J. B. Leavitt, Horace Raynor, and C. W. Stump, jr., the total area mapped being 1,070 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. Of this area 64 square miles is in Charlton County, Ga. For the control of these areas and of the Hilliard, St. Marys, Green Cove prings, and St. Augustine quadrangles, in Clay, Duval, Nassau, nd St. Johns counties, C. B. Kendall, E. L. McNair, and H. S. enseney ran 471 miles of primary traverse and set 37 permanent narks, and W. S. Gehres, S. L. Parker, and J. C. Hilliard ran 297 niles of primary levels and set 64 permanent bench marks.

Georgia.—The survey of the Everett City, Bladen, and Hortense uadrangles, in Camden, Charlton, Wayne, and Liberty counties, was ompleted and that of the Nahunta, Kingsland, Jesup, and Moniac uadrangles, in Camden, Charlton, Wayne and Liberty counties, was egun by Albert Pike, R. L. Harrison, L. L. Lee, J. M. Rawls, C. W. Goodlove, J. A. Duck, T. H. Moncure, F. W. Farnsworth, E. J. Essick, W. F. Hicks, and R. H. Kilmer, the total area mapped being 1,211 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of these areas and of the Boulogne, Folkstone, Hinesville, Savannah, Winokur, Ludowici, Limerick, Darien, Offerman, Brunswick, Travisville, Eulonia, Glenville, Waycross, Coffee, Sessoms, Wilcox, Broxton, Leliaton, Fargo, Haylow, Naylor, Valdosta, Sparks, Tifton, and Homerville quadrangles, in Camden, Charlton, Liberty, Chatham, Ware, Pierce, McIntosh, Wayne, Clinch, Echols, Coffee, Jeff Davis, Appling, Glynn, Berrien, and Colquitt counties, Oscar Jones, E. L. McNair, and H. S. Senseney ran 1,164 miles of primary traverse and set 93 permanent bench marks, and R. G. Clinite and Messrs. Hicks and Senseney ran 495 miles of primary levels and established 145 permanent bench marks. Of the primary traverse, 18 miles and 2 permanent marks are in South Carolina.

New Hampshire.—The survey of the Mount Pawtuckaway, Alton, and Gilmanton quadrangles, in Strafford, Rockingham, Belknap, and Merrimack counties, was commenced by Hersey Munroe, L. B. Roberts, A. J. Kavanagh, J. B. Metcalfe, jr., and Robert Muldrow, the total area mapped being 99 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas and of the Suncook quadrangle, in Merrimack, Rockingham, and Hillsboro counties, G. T. Hawkins and Mr. Metcalfe occupied 13 triangulation stations and marked 11, and C. H. Semper ran 116 miles of primary levels and established 26 permanent bench marks.

New Mexico.—The survey of the United States portions of the Columbus, Hermanas, Mount Riley, and Camel Mountain quadrangles, in Dona Ana and Luna counties, was completed, and that of the Noria quadrangle, in Dona Ana and Luna counties, was begun by J. E. Blackburn, A. J. Ogle, Bishop Moorhead, C. C. Gardner, F. A. Danforth, J. G. Staack, H. K. McDonald, J. L. Lewis, R. H. Reineck, F. L. Whaley, W. R. Chenoweth, C. E. Giffin, and G. C. Douglas, the total area mapped being 985 square miles, for publication on the scale of 1:62,500, with contour intervals of

10 and 50 feet. For the control of these areas and of the Cancitillo, Ash Springs No. 1, Victorio, and Big Hatchet Peak quadrangles, in Dona Ana and Grant counties, C. L. Nelson, G. T. Hawkins, and B. H. Yoakum occupied 38 triangulation stations and marked 39, and F. A. Danforth, R. B. Steele, and R. W. Burchard ran 437 miles of primary levels and established 125 permanent bench marks.

Pennsylvania.—For the control of the Pocono quadrangle, which includes the artillery range in the vicinity of Tobyhanna, in Monroe and Lackawanna counties, R. H. Chapman and E. C. Burt occupied 6 triangulation stations and marked 3, and Mr. Burt ran 30 miles of primary levels and established 11 permanent bench marks.

Texas.—The survey of the Tascotal Mesa and Agua Fria quadrangles, in Brewster and Presidio counties, was completed and that of the Buck Hill, Jordan Gap, Santiago Peak, and Nine Point Mesa quadrangles, in Brewster County, was begun by A. O. Burkland, S. G. Lunde, R. W. Berry, O. H. Nelson, S. T. Penick, C. C. Holder, H. H. Hodgeson, C. G. Anderson, H. E. Simmons, W. O. Tufts, R. R. Monbeck, and J. R. Eakin, the total area mapped being 983 square miles, for publication on the scale of 1:62,500, with contour intervals of 25 and 50 feet For the control of these areas and of the Hood Spring, Bone Spring, Bullis Gap, and Dove Mountain quadrangles, in Brewster and Presidio counties, Mr. Anderson and J. R. Ellis occupied 10 triangulation stations and marked 8; D. S. Birkett and R. R. Monbeck ran 268 miles of primary levels and established 66 permanent bench marks; and Mr. Burkland established 5 permanent bench marks by vertical angulation.

Virginia.—The survey of the Kilmarnock, Mathews, Urbanna, Heathsville, and Morattico quadrangles and the resurvey of the Ewell quadrangle, in Middlesex, Mathews, Lancaster, Gloucester, King and Queen, Northumberland, and Richmond counties, was completed, and the survey of the Toano, Disputanta, Tappahannock, Charles City, Aylett, and Surry quadrangles, in Charles City, Henrico, New Kent, King and Queen, James City, King William, Caroline, Hanover, Surry, Prince George, and Essex counties was begun by T. F. Slaughter, Albert Pike, L. B. Roberts, W. H. S. Morey, R. L. Harrison, E. I. Ireland, J. B. Metcalfe, jr., C. H. Davey, Klett McKinley, J. I. Gayetty, J. A. Duck, S. H. Birdseye, S. T. Penick, J. M. Whitman, Duncan Hannegan, F. W. Hughes, Kostka Mudd, W. J. Lloyd, Fred McLaughlin, A. T. Fowler, Olinus Smith, C. S. Wells, J. H. Wilke, and P. W. McMillen, the total new area surveyed being 2,004 square miles and that resurveyed being 17 square miles, for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet. Of the area resurveyed 9 square miles is in Somerset County, Md. For the control of these areas E. L. McNair, J. H. Wilson, and Olinus Smith ran 721 miles of primary traverse and set 63 permanent marks, and F. J. McMaugh, F. L. Shalibo, DeWitt McLaughlin, E. E. Harris, Stanley Druhot, Kostka Mudd, and S. R. Archer ran 1,009 miles of primary levels and established 234 permanent bench marks.

GENERAL OFFICE WORK.

Results of computations for vertical and horizontal control were copied and catalogued.

The computations of control data were made principally by D. H. Baldwin, T. M. Bannon, D. S. Birkett, G. T. Hawkins, Oscar Jones, C. B. Kendall, F. J. McMaugh, E. L. McNair, J. B. Metcalfe, jr., C. L. Nelson, H. S. Senseney, J. G. Staack, S. G. Lunde, S. R. Archer, and J. H. Wilson, under the immediate supervision of E. M. Douglas, geographer. Computing by L. F. Biggs and C. F. Urquhart was done in the Sacramento office. S. S. Gannett, geographer, was engaged in preparing manuscript and compiling data for bulletins submitted for publication, in miscellaneous computations, and in furnishing triangulation and leveling data for field and office use.

J. H. Renshawe was engaged during the year in preparing relief maps of the United States, of Salem, Oreg., and vicinity, and of the State of Ohio and in revising the relief map of Alaska.

The preparation of the special topographic maps to be used in the transcontinental guidebooks was continued by A. C. Roberts and R. C. McKinney. The different railroads supplied all available profile and alinement data and rendered other valuable assistance.

INSPECTION OF TOPOGRAPHIC MAPPING.

W. M. Beaman continued the supervision of the field and office work on the map of Washington and vicinity, spent three months inspecting field work in the Rocky Mountain, Northwestern, and Pacific divisions, and two months in revision work in Arizona. A. M. Walker spent three months in the field inspection of work in the Atlantic, Central, and Rocky Mountain divisions. The office duties of Messrs. Beaman and Walker covered the supervision of the preparation of all topographic field sheets for engraving and photolithography. In the examination of sheets prior to their transmission they were assisted throughout the year by L. S. Leopold.

J. H. Renshawe spent the entire year in the office on special work in relief shading, as reported in detail above.

MILLIONTH-SCALE MAP OF THE UNITED STATES.

Of the work in progress last year on the 1:1,000,000-scale map of the United States, under the direction of A. F. Hassan, the base map of Idaho (parts of sheets K-11, K-12, L-11, L-12, and M-11) was completed. About 10,000 additional square miles of the base map of

Colorado (part of sheet J–13) was compiled. The mapping of the Coastal Plain area of Texas, between Brazos River and the Rio Grande, was 90 per cent completed, and the base maps of South Carolina and Minnesota were revised. Four base maps of areas in the vicinity of Saypo, Billings, Bozeman, and Bowdoin, Mont., and one of Clarke, Choctaw, and Washington counties, Ala., were prepared for the geologic branch.

ATLANTIC DIVISION.

FIELD WORK.

Summary.—During the year topographic mapping was carried on in Delaware, Florida, Georgia, Maine, Mississippi, New York, New Hampshire, Pennsylvania, Vermont, Virginia, and West Virginia. This work included the completion of the survey of 15 quadrangles and of the resurvey of 2 quadrangles, in addition to which 31 quadrangles were partly surveyed and 2 were partly resurveyed.

Primary triangulation and primary traverse were carried on by nine parties in Delaware, Florida, Georgia, Maine, New Hampshire, New York, Pennsylvania, Vermont, and Virginia.

Topographic surveys in Atlantic division from July 1, 1916, to June 30, 1917.

State.	Contour interval.	For publication on scale of— 1:62,500 New.	1:62,500 Resurvey.	1:21,120 New.	Total area surveyed.	Primary levels. Distance run.	Primary levels. Bench marks.	Primary traverse. Distance run.	Primary traverse. Permanent marks.	Triangulation stations. Occupied.	Triangulation stations. Marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Delaware	10, 20	534			534	129	22	123	8		
Florida	10	1,016			1,016	297	64	471	37		
Georgia	10	1,320			1,320	494	145	1,146	91		
Maine	20	210	106		316	115	28			19	24
Maryland	10		18		18						
New Hampshire	20	99	136		235	132	29			13	11
New York	20	214		90	304	45	11	185	26		
Pennsylvania	20	228			228	91	32			6	3
South Carolina								18	2		
Vermont	20	67			67	53	16			9	9
Virginia	10, 50	2,004	332		2,336	1,062	249	721	63		
West Virginia	50		412		412	88	23				
		5,692	1,004	90	6,786	2,506	619	2,664	227	47	47

Maine.—For the continuation of cooperative topographic surveys the Public Utilities Commission allotted $5,000 and the United States Geological Survey allotted an equal amount. The survey of the Winn quadrangle, in Penobscot County, was completed by W. H. Griffin, J. B. Metcalfe, jr., and C. W. Arnold, the total area mapped being 210 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of the Winn and Seboeis quadrangles, in Penobscot County, J. C. Beam ran 90 miles of primary levels and established 21 permanent bench marks. For the control of the Millinocket and Mattewamkeag quadrangles, in Penobscot County, and of the Brooks and Burnham quadrangles, in Waldo, Somerset, and Kennebec counties, Oscar Jones occupied 19 triangulation stations and marked 24.

Maine and New Hampshire.—The resurvey of the Dover quadrangle, in York County, Maine, and Rockingham and Strafford counties, N. H., was completed by Hersey Munroe, and that of the York quadrangle, in the same counties, was continued by J. H. Wheat, W. H. Griffin, C. W. Arnold, and Robert Muldrow, the total area mapped being 242 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. Of this area 106 square miles is in Maine. For the control of these areas C. W. Arnold and C. H. Stewart ran 41 miles of primary levels and established 10 permanent bench marks, of which 25 miles and 7 marks were in Maine.

New York.—For the continuation of cooperative topographic surveys the State engineer and surveyor allotted $10,000 and the United States Geological Survey an equal amount. The survey of the Oswegatchie quadrangle, in Herkimer, Lewis, and St. Lawrence counties, was completed and that of the Cranberry Lake quadrangle, in the same counties, was continued by W. J. Lloyd, A. P. Meade, J. M. Whitman, and G. H. Guerdrum, the total area mapped being 214 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Andes quadrangle, in Delaware, Sullivan, and Ulster counties, F. J. McMaugh ran 22 miles of primary traverse and set 5 permanent marks. For the control of the Cranberry Lake, Stark, Nicholville, Childwood, and Rathbone quadrangles, in Hamilton, Herkimer, St. Lawrence, Franklin, and Steuben counties, C. B. Kendall ran 116 miles of primary traverse, set 21 permanent marks, and occupied 37 secondary triangulation stations along the lake shore, and K. E. Schlachter and F. L. Shalibo ran 45 miles of primary levels and established 11 permanent bench marks.

In addition to the cooperative work in New York, a survey of an area, including the Plattsburg training camp, in Clinton County, was made for the use of the United States Army by C. E. Cooke, F. W. Crisp, and E. W. Bowler, the area mapped being 90 square miles, for publication on the scale of 3 inches to 1 mile, with a contour interval of 5 feet. For the control of this area Mr. Crisp ran 47 miles of primary traverse.

Pennsylvania.—The survey of the Newville quadrangle, in Cumberland, Adams, Perry, and Franklin counties, was completed by Duncan Hannegan, R. A. Kiger, and C. H. Davey, the area mapped being 228 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area DeWitt McLaughlin ran 51 miles of primary levels and established 21 permanent bench marks.

Vermont.—For the continuation of cooperative topographic surveys the governor of Vermont allotted $2,500 and the United States Geological Survey an equal amount. The survey of the Waitsfield quadrangle, in Addison and Washington counties, was commenced by W. H. S. Morey and K. E. Schlachter, the area mapped being 67 square miles for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Waitsfield, Bolton, Montpelier, Northfield, Hyde Park, and Barre quadrangles, in Washington, Lamoille, Addison, and Orange counties, Oscar Jones and C. B. Kendall occupied and marked 9 primary triangulation stations, and for the control of the Waitsfield quadrangle Mr. Schlachter ran 53 miles of primary levels and established 16 permanent bench marks.

Virginia.—For the continuation of cooperative topographic surveys the State geologist allotted $4,500 and the United States Geological Survey an equal amount. The resurvey of the Wise quadrangle and that of the coal area within the Coeburn quadrangle, in Russell, Wise, and Scott counties, was completed by Fred McLaughlin, T. F. Slaughter, Kostka Mudd, and J. B. Leavitt, the total area mapped being 324 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of these areas Mr. McLaughlin ran 53 miles of primary levels and established 15 permanent bench marks.

West Virginia.—For the continuation of cooperative topographic surveys the State geologist allotted $4,304.62 and the United States Geological Survey allotted $2,000. A resurvey of the portions of the Davis, Elk Garden, Onego, Keyser, and Horton quadrangles lying in Mineral and Tucker counties was completed by E. I. Ireland, J. I. Gayetty, and Klett McKinley, the total area mapped being 412 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this area E. E. Harris ran 76 miles of primary levels and established 20 permanent bench marks. For the control of the Piedmont quadrangle, in Tucker, Mineral, and Grant counties, K. F. Maxcy ran 12 miles of primary levels and established 3 permanent bench marks.

OFFICE WORK.

The drafting of the following topographic maps was completed: Black Lake, Ga.; Winn, Maine; Dover, Maine-N. H.; Oswegatchie and Plattsburg training camp, N. Y.; Newville, Pa.; Kilmarnock, Mathews, Urbanna, Heathsville, Ewell, and Morattico, Va.

Progress in the drafting of additional sheets was made as follows: York, Maine-N. H., 40 per cent; Memphis, Tenn.-Ark., 70 per cent; Waitsfield, Vt., 15 per cent; Coeburn, Va., 43 per cent; Davis, W. Va., 58 per cent; Elk Garden, W. Va., 5 per cent; Keyser, W. Va., 25 per cent.

Primary-level circuits were adjusted for the following quadrangles: Black Lake, Ga.; Seboeis, Winn, and York, Maine; Dover, N. H.; Childwold, Cranberry Lake, Plattsburg, Potsdam, Rathbone, and Stark, N. Y.; Newville, Pa.; Charles City, Kilmarnock, Heathsville, Mathews, Morattico, Surry, Disputanta, Tappahannock, Toano, and Urbanna, Va.; Waitsfield, Vt.; Davis, Elk Garden, and Keyser, W. Va.

Geographic positions were computed for the following quadrangles: Cedar Creek, Harrington, Rehoboth, and Millsboro, Del.; Cambon, Hilliard, Ates Creek, Boulogne, Green Cove Springs, Kingsland, Middleburg, Orange Park, St. Marys, Jacksonville, Lawtey, and Maclenny, Fla.; Black Lake, Eulonia, Griswoldville, Hinesville, Jesup, Limerick, Ludowici, Maclenny, Ossabaw Island, Moniac, Bladen, Nahunta, Glennville, and Savannah, Ga.; Brooks, Burnham, Mattawamkeag, Millinocket, and Seboeis, Maine; Andes, Childwold, Cranberry Lake, Nicholville, Plattsburg, Stark, and Tupper Lake, N. Y.; Aylett, Charles City, Disputanta, Doswell, Heathsville, King William, Montross, New Kent, Piney Point, Morattico, Surry, Tappahannock, Toano, Urbanna, and Williamsburg, Va.; Bolton, Burlington, Montpelier, Northfield, and Waitsfield, Vt.; Davis, Elk Garden, and Keyser, W. Va.

CENTRAL DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Illinois, Iowa, Kentucky, Michigan, Minnesota, Missouri, and Wisconsin. The work included the completion of the survey of 18 quadrangles and the resurvey of 3 quadrangles, in addition to which 6 quadrangles were partly surveyed.

Primary triangulation and primary traverse were carried on by three parties in Illinois, Kentucky, Michigan, and Wisconsin.

Topographic surveys in central division from July 1, 1916, to June 30, 1917.

State.	Contour interval.	For publication on scale of 1:62,500.		Total area surveyed.	Primary levels.		Primary traverse.		Triangulation stations.	
		New.	Resurvey.		Distance run.	Bench marks.	Distance run.	Permanent marks.	Occupied.	Marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Illinois	20	702	30	732	122	29	163	7	......	......
Iowa	20	151	......	151	......	......	......	......	......	......
Kentucky	20, 50	80	468	548	61	11	......	......	2	1
Michigan	5, 10, 20	1,103	......	1,103	543	143	376	33	......	......
Minnesota	10	191	......	191	98	22	......	......	......	......
Missouri	10	25	201	226	24	4	......	......	......	......
Ohio	......	......	......	......	148	22	......	......	......	......
Wisconsin	20	90	......	90	68	16	77	6	......	......
	......	2,342	699	3,041	1,064	247	616	46	2	1

Illinois.—The governor of Illinois allotted $9,000 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. The survey of the Vienna, Vermont, Goodhope, La Harpe, and Dixon quadrangles and of the Illinois portion of the Campbell Hill quadrangle, in Johnson. Massac, Pulaski, McDonough, Warren, Henderson, Hancock, Randolph, Lee, and Ogle counties, was completed by J. A. Duck, L. B. Glasgow, M. A. Roudabush, Gilbert Young, L. L. Lee, C. W. Goodlove, Ralph Wilcoxon, R. L. Harrison, and F. W. Hughes, the total area mapped being 702 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The resurvey of the Wilmington quadrangle, in Will and Kankakee counties, was completed by Mr. Harrison, the area mapped being 30 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Vermont and Dongola quadrangles. in Fulton, McDonough, Schuyler, Union, Johnson, and Pulaski counties, J. H. Wilson ran 163 miles of primary traverse and set 7 permanent marks. For the control of the Dixon and Oregon quadrangles, in Lee and Ogle counties, H. S. Senseney ran 122 miles of primary levels and established 29 permanent bench marks.

Iowa.—The State Geological Survey allotted $1,750 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. The survey of the Chariton quadrangle, in Lucas and Warren counties, was completed and that of the Attica quadrangle, in Lucas, Monroe, and Marion counties, was begun by W. L. Miller, the total area mapped being 151 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

Kentucky.—The Kentucky Geological Survey allotted $10,000 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. The resurvey of the Harlan and Hyden quadrangles, in Harlan, Leslie, and Perry counties, was completed by J. R. Eakin, F. W. Farnsworth, S. A. Judson, and E. J. Essick, the total area mapped being 468 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. The survey of the Kentucky portion of the Golconda quadrangle, in Livingston and Crittenden counties, was continued by C. W. Goodlove and W. S. Gehres, the area mapped being 80 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Harlan and Hyden quadrangles S. R. Archer ran 61 miles of primary levels and established 11 permanent bench marks, and E. L. McNair occupied 2 triangulation stations and marked 1.

Michigan.—For the continuation of cooperative topographic surveys the State geologist allotted $15,000 and the United States Geological Survey allotted an equal amount. The survey of the Elsie, Perrinton, Cedar Springs, Kalamazoo, Ionia, Lowell, Saginaw, Bay City, and Mount Pleasant quadrangles, in Clinton, Shiawassee, Gratiot, Saginaw, Ionia, Montcalm, Kent, Kalamazoo, Allegan, Barry, Eaton, Saginaw, Bay, and Isabella counties, was completed by L. L. Lee, J. G. Staack, Fred Graff, jr., E. L. Hain, S. H. Birdseye, A. B. Searle, Robert Muldrow, A. L. Opdycke, J. H. Jennings, E. C. Burt, C. L. Sadler, A. T. Fowler, and R. M. Harrington, the total area mapped being 1,103 square miles, for publication on the scale of 1:62,500, with contour intervals of 5, 10, and 20 feet. For the control of the Ionia, Lowell, Fenwick, Rives Junction, Big Prairie, Grove, and Springport quadrangles, in Ionia, Montcalm, Jackson, Ingham, Barry, Eaton, Kent, Allegan, Calhoun, Newaygo, and Mecosta counties, E. C. Bisbee and R. G. Clinite ran 543 miles of primary levels and established 143 permanent bench marks. For the control of the White Cloud, Big Prairie, Grove, Smyrna, Howard City, Big Rapids, Hersey, Nirvana, Tustin, Luther, Manton, Mesick, Fife Lake, Kalkaska, Bellaire, Elk Rapids, East Jordan, Torch Lake, Bay Shore, and Inwood quadrangles, in Newaygo, Mecosta, Montcalm, Kent, Osceola, Wexford, Grand Traverse, Kalkaska, Antrim, and Charlevoix counties, J. H. Wilson and H. S. Senseney ran 376 miles of primary traverse and set 33 permanent bench marks.

Minnesota.—The State drainage engineer of Minnesota allotted $4,250 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. The survey of the St. Francis and Pillager quadrangles, in Anoka, Isanti, Cass, Crow Wing, and Morrison counties, was completed by F. B. Barrett, W. S. Gehres, S. G. Lunde, J. L. Lewis, and J. M. Rawls, the total area mapped being 191 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of the Belle Prairie and Cushing quadrangles R. G. Clinite ran 98 miles of primary levels and established 22 permanent bench marks.

Missouri.—The State geologist of Missouri allotted $3,000 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. However, the State funds did not become available, and the work was continued with Federal money alone. The resurvey of the Halltown quadrangle (a portion of which had previously been resurveyed as the Aurora special), in Lawrence, Christian, and Greene counties, was begun, and the resurvey of that portion of the Stotts City and Greenfield quadrangles included within Greene County was completed by F. W. Hughes, the total area resurveyed being 201 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. The survey of the Missouri portion of the Campbell Hill quadrangle, in Perry County, was completed by Gilbert Young and M. A. Roudabush, the area mapped being 25 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Stotts City and Sarcoxie quadrangles, in Lawrence and Jasper counties, F. L. Whaley ran 24 miles of primary levels and established 4 permanent bench marks.

Ohio.—For the purpose of correcting discrepancies that were known to exist in a few scatered bench-mark elevations, S. R. Archer ran 148 miles of primary levels and established 22 permanent bench marks.

Wisconsin.—The State geologist of Wisconsin allotted $3,000 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. The survey of the Mazomanie quadrangle, in Iowa, Dane, and Sauk counties, was begun by R. M. Herrington, the area mapped being 90 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area J. H. Wilson ran 77 miles of primary levels and set 6 permanent marks, and R. G. Clinite ran 68 miles of primary levels and established 16 permanent bench marks.

OFFICE WORK.

The drafting of the following topographic maps was completed: Vienna, Goodhope, La Harpe, Dixon, and Wilmington, Ill.; Lynn, Ind.; Chariton, Iowa; Harlan, Nolansburg, and Hyden, Ky.; Elsie, Perrinton, Cedar Springs, Kalamazoo, Ionia, Lowell, Saginaw, Bay City, and Mount Pleasant, Mich.; St. Francis and Pillager, Minn.; Halltown, and Spring City mining district, Mo.; Campbell Hill, Mo.-Ill.; Kelleys Island and Peebles, Ohio; Ripon, Wis.

Progress in the drafting of additional sheets was made as follows: Vermont, Ill., 18 per cent; Attica, Iowa, 55 per cent; Golconda, Ky.-Ill., 65 per cent; Greenfield, Mo., 8 per cent; Mazomanie, Wis., 40 per cent.

Primary-level circuits were adjusted for the following quadrangles: Lynn, Ind.; Dixon, Ill.; Fords Ferry, Golconda, Harlan, Hyden, and Nolansburg, Ky.; Bay City, Big Prairie, Carson City, Cedar Springs, Fenwick, Grove, Ionia, Kalamazoo, Lowell, Mount Pleasant, Muir, Rives Junction, Saginaw, Smyrna, and Springport, Mich.; Carthage, Greenfield, Halltown, Sarcoxie, and Stotts City, Mo.; Belle Prairie and Cushing, Minn.; Beardsley and Peever, Minn.-S. Dak.; Oak Hill, Roxabel, South Charleston, Springfield, Vermilion, and Wellington, Ohio.

Geographic positions were computed for the following quadrangles: Dongola, Jonesboro, Mound City, Thebes, and Vermont, Ill.; Barbourville, Corbin, Harlan, Hyden, Logmont, Middlesboro, and Pineville, Ky.; Bay City, Bay Shore, Bellaire, Big Prairie, Big Rapids, Elk Rapids, Fife Lake, Grove, Hersey, Howard City, Kalkaska, Luther, Manton, Nirvana, Smyrna, Torch Lake, Tustin, and White Cloud, Mich.; Joplin district, Mo.; Craig, Maitland, Tarkio, and Atchison, Mo.-Kans.-Nebr.; Cross Plains, Denzer, Lone Rock, and Mazomanie, Wis.

ROCKY MOUNTAIN DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Colorado, Kansas, Minnesota, Missouri, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming. The work included the completion of the survey of 27 quadrangles and the resurvey of 1 quadrangle and 1 special area, in addition to which 15 quadrangles were partly surveyed. Primary traverse and primary triangulations were carried on by four parties in Kansas, Missouri, Nebraska, North Dakota, Oklahoma, New Mexico, Texas, and Wyoming.

Topographic surveys in Rocky Mountain division from July 1, 1916, to June 30, 1917.

State.	Contour interval.	For publication on scale of— 1:125,000 (new).	1:62,500. New.	1:62,500. Resurvey.	1:31,680 (new).	1:24,000 (resurvey).	Total area surveyed.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*
Colorado	50	530					530
Kansas	10			236			236
Minnesota	10		198				198
Missouri	20		163				163
Nebraska	20		65				65
New Mexico	10,50,100	387	985			8	1,380
North Dakota							
Oklahoma	25		57				57
South Dakota	10		139				139
Texas	1,5,25		983		693		1,676
Wyoming	100	684					684
		1,601	2,590	236	693	8	5,128

State.	Primary levels. Distance run.	Primary levels. Bench marks.	Primary traverse. Distance run.	Primary traverse. Permanent marks.	Triangulation stations. Occupied.	Triangulation stations. Marked.
	Miles.		*Miles.*			
Colorado	90	24				
Kansas	171	18	6			
Minnesota	68	20				
Missouri	19	5	55	5		
Nebraska			14			
New Mexico	519	150			48	53
North Dakota			61	7		
Oklahoma	26	5	492	58		
South Dakota	5	1				
Texas	371	90			14	12
Wyoming	115	30				
	1,384	343	628	70	62	65

Colorado.—The survey of the Home and Naturita quadrangles, in Jackson, Larimer, Montrose, and San Miguel counties, was completed by Basil Duke, D. H. Watson, and C. A. Stonesifer, the total area mapped being 438 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The mapping of the Daton Peak quadrangle, in Routt and Moffat counties, was completed by Mr. Duke, the area mapped being 92 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of the Naturita and Daton Peak quadrangles R. W. Burchard ran 90 miles of primary levels and established 24 permanent bench marks. In connection with the mapping of the Naturita quadrangle Mr. Burchard made a plan and profile survey of portions of San Miguel and Dolores rivers, the distance traversed being 83 linear miles, for publication on the scale of 1:48,000.

Kansas.—The resurvey of the Columbus quadrangle, in Cherokee County, was completed by R. A. Kiger, F. L. Whaley, and R. M. Herrington, the area mapped being 236 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of this area Mr. Whaley ran 171 miles of primary levels and established 18 permanent bench marks.

Missouri-Nebraska.—The survey of the Craig quadrangle, in Holt County, Mo., and Richardson County, Nebr., was completed by C. L. Sadler, the area mapped being 228 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. Of this area, 163 square miles is in Missouri. For the control of the Craig quadrangle J. H. Wilson ran 75 miles of primary traverse—55 in Missouri, 14 in Nebraska, and 6 in Kansas—and set 5 permanent bench marks, all in Missouri, and H. S. Senseney ran 19 miles of primary levels and established 5 permanent bench marks, all in Missouri.

Minnesota-South Dakota.—The survey of the Peever and Beardsley quadrangles, in Roberts County, S. Dak., and Traverse and Big Stone counties, Minn., was completed by S. P. Floore and A. J. Kavanagh, the total area mapped being 337 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. Of this area, 139 square miles is in South Dakota. For the control of these areas Mr. Kavanagh ran 73 miles of primary levels and established 21 permanent bench marks, 5 miles and 1 bench mark being in South Dakota.

North Dakota.—For the control of the Wilton quadrangle, in Oliver County, J. H. Wilson ran 61 miles of primary traverse and set 7 permanent marks.

New Mexico.—The survey of the Pelona quadrangle, lying partly in the Datil National Forest, in Socorro County, was completed by C. C. Gardner, the area mapped being 387 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area, 200 square miles is within the national forest. For the control of the Hagerman, Queen, Orange, Carlsbad, Avis, and Hope quadrangles, in Eddy, Otero, Lincoln, and Chaves counties, C. L. Nelson and B. H. Yoakum occupied 9 triangulation stations and marked 13. For the control of the Hagerman quadrangle R. W. Burchard ran 82 miles of primary levels and established 25 permanent bench marks.

The revision of the map of the Tyrone district, in Grant County, was completed by O. G. Taylor, the area covered being 8 square miles.

Oklahoma.—The survey of the Hominy quadrangle, in Osage County, was commenced by C. C. Holder and R. R. Monbeck, the area mapped being 57 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the Hominy, Sac and Fox, Mallon, Yale, Skedee, Gray Horse, and Belford quadrangles, in Osage, Okfuskee, Lincoln, Creek, Payne, Pawnee, Kay, and Noble counties, B. H. Yoakum and W. F. Hicks ran 492 miles of primary traverse and set 58 permanent marks. For the control of the Hominy quadrangle Mr. Yoakum ran 26 miles of primary levels and established 5 permanent bench marks.

Texas.—For the completion of the cooperative topographic survey of Harris County the county contributed $9,636.07 and the United States Geological Survey allotted $5,000. The mapping of the Burnett Bay, Fauna, Humble, Crosby, La Porte, and Louetta quadrangles, the City of Houston portions of the Settegast, Houston Heights, Bellaire, and Park Place quadrangles, and the Harris County portions of the Moonshine Hill, Rose Hill, Scott Ranch, Spring, Stuebner, Walley, Weeden, Cedar Bayou, and Morgan Point quadrangles was completed, the total area mapped being 405 square miles, for publication on the scale of 1:31,680, with contour intervals of 1 and 5 feet. This work was done by S. T. Penick, T. P. Pendleton, Olinus Smith, C. A. Stonesifer, W. F. Hicks, B. A. Jenkins, Cornelius Schnurr, C. C. Holder, H. W. Peabody, F. A. Danforth, D. H. Watson, O. H. Nelson, L. B. Roberts, E. R. Bartlett, T. H. Moncure, R. R. Monbeck, J. B. Leavitt, A. J. Ogle, and O. G. Taylor.

In addition to the cooperative work the mapping of the West Wichita Falls, Iowa Park, Fowlkes, Beaver Creek, and Electra quadrangles, in Wichita and Wilbarger counties, was completed by R. W. Berry, E. R. Bartlett, R. R. Monbeck, J. G. Staack, and R. W. Burchard, the total area mapped being 288 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of these areas Mr. Monbeck ran 103 miles of primary levels and established 19 permanent bench marks. In connection with the scheme of triangulation in New Mexico C. L. Nelson and B. H.

Yoakum occupied and marked 1 triangulation station for the control of the Guadalupe Peak quadrangle, in El Paso County.

Wyoming.—The mapping of the Afton quadrangle, lying partly in the Wyoming National Forest, in Lincoln County, was continued by J. H. Wilke, Cornelius Schnurr, R. H. Reineck, and A. J. Ogle, the area mapped being 684 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 615 square miles lies within the national forest. For the control of the Afton and Daniel quadrangles, in Lincoln County, D. C. Birkett ran 115 miles of primary levels and established 27 permanent bench marks and Mr. Wilke established 3 permanent bench marks by vertical angles. For the control of the Leo, Hanna, and Saddleback Hills quadrangles, in Carbon County, C. L. Nelson occupied and marked 3 triangulation stations.

OFFICE WORK.

The drafting of the following topographic maps was completed: Home and Daton Peak, Colo.; Columbus, Kans.; Craig, Mo.-Nebr.; Peever and Beardsley, Minn.-S. Dak.; Pelona, Tyrone district, Columbus, and Hermanas, N. Mex.; Aldine, Cedar Bayou, City of Houston, Burnett Bay, Fauna, Humble, Crosby, La Porte, Louetta, Settegast, Satsuma, Houston Heights, Harmaston, Hockley, Huffman, Bellaire, Park Place, Spring, Genoa, Moonshine Hill, Morgan Point, Rose Hill, Scott Ranch, Seabrook, Trinity Bay, Stuebner, Swanson, Walley, Weeden, Waller-Holik-Joseph, West Wichita Falls, Iowa Park, and Electra, Tex.

The drafting of the profile sheets of Dolores and San Miguel rivers, Colo., and Gila River, N. Mex., was 90 per cent completed.

Progress in the drafting of additional sheets was made as follows: Naturita, Colo., 39 per cent; Fowlkes, Tex., 35 per cent; Afton, Wyo., 96 per cent.

Primary-level circuits were adjusted for the following quadrangles: Naturita and Daton Peak, Colo.; Joplin district, Kans.; Hagerman and Roswell, N. Mex.; Hominy, Okla.; Beardsley and Peever, S. Dak.-Minn.; Daniel and Afton, Wyo.

Geographic positions were computed for the following quadrangles: Columbus and Joplin district, Kans.; Atchison, Maitland, Craig, and Tarkio, Kans.-Mo.-Neb.; Washburn and Wilton, N. Dak.; Pelona, N. Mex.; Belford, Claremore, Gray Horse, Hominy, Kaw, Mallon, Pawhuska, Sac and Fox, Skedee, and Yale, Okla.; Brenham, Katy, Liberty, Sealy, and Waller, Tex.; Hanna and Saddleback Hills, Wyo.

NORTHWESTERN DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Idaho, Montana, Oregon, and Washington. The work included the completion of the survey of 4 quadrangles, in addition to which 7 quadrangles were partly surveyed. A profile survey was made of two rivers, the distance traversed being 77 linear miles. Primary traverse and primary triangulation were carried on by five parties in Idaho, Montana, Oregon, and Washington.

Topographic surveys in northwestern division from July 1, 1916, to June 30, 1917.

State.	Contour intervals.	For publication on scale of—		Total area surveyed, new.	Primary levels.		Primary traverse.		Triangulation stations.	
		1:125,000	1:62,500		Distance run.	Bench marks.	Distance run.	Permanent marks.	Occupied.	Marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Idaho	100	702	240	942	135	50	....	....	5	5
Montana	100	722	....	722	206	58	....	....	9	9
Oregon	25, 50, 100	240	19	259	....	2	....	....	25	25
Washington	50, 100	1, 579	....	1, 579	129	28	150	15	....	....
	....	3, 243	259	3, 502	470	138	150	15	39	39

Idaho.—The survey of the Paradise Valley quadrangle, in Bannock, Bingham, and Bonneville counties, was completed and that of the Ozone quadrangle, in the same counties, was begun by C. G. Anderson, the total area mapped being 240 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of these quadrangles Mr. Anderson occupied and marked 5 triangulation stations and E. M. Bandli ran 56 miles of primary levels and established 18 permanent bench marks. The survey of the Custer quadrangle, lying partly in the Challis and Sawtooth national forests, in Custer County, was continued by Albert Pike and H. E. Burney, the area mapped being 620 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 550 square miles is included in the national forests. In connection with the mapping of the Custer quadrangle, Mr. Pike made a profile survey of upper Salmon River, the distance traversed being 30 linear miles, for publication on the scale of 1:31,680. For the control of the Custer and Challis quadrangles, in Custer County, Mr. Bandli ran 79 miles of primary levels and established 32 permanent bench marks.

Idaho-Montana.—The mapping of the St. Regis quadrangle, lying partly in the St. Joe, Lolo, and Cabinet national forests, in Shoshone County, Idaho, and Mineral and Sanders counties, Mont., was completed by J. E. Blackburn, the area mapped being 232 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. This area lies entirely within the national forests, 82 square miles being in Idaho.

Montana.—The mapping of the Drummond quadrangle, in Granite, Missoula, and Powell counties, was continued and that of the

Swan Lake quadrangle, lying within the Lewis and Clark, Kootenai, and Cabinet national forests, in Flathead and Missoula counties, was begun by K. W. Trimble, R. C. Seitz, and J. W. Muller, the total area mapped being 572 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 178 square miles is within the national forests. For the control of the Swan Lake quadrangle Mr. Seitz ran 60 miles of primary levels and established 10 permanent bench marks and Mr. Muller established 3 permanent bench marks by vertical angles. For the control of the Huntley, Elso, Fattig, and Flat Willow quadrangles, in Yellowstone, Fergus, and Musselshell counties, G. T. Hawkins occupied and marked 9 triangulation stations and D. S. Birkett ran 146 miles of primary levels and established 45 permanent bench marks. In connection with the mapping of the Swan Lake quadrangle Mr. Muller made a profile survey of the lower part of Swan River, the distance traversed being 47 linear miles, for publication on the scale of 1:48,000.

Oregon.—For the continuation of cooperative topographic surveys the State engineer allotted $1,000 and the United States Geological Survey an equal amount. The mapping of the Oregon portion of the Troutdale quadrangle, in Multnomah County, was completed by Charles Hartmann, the area mapped being 19 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the Cline Falls, Heisler, Prineville, and Round Mountain quadrangles, in Crook and Wasco counties, Mr. Hartmann occupied and marked 11 triangulation stations.

In addition to the cooperative work in Oregon, the mapping of the Twickenham quadrangle, lying partly in the Ochoco National Forest, in Wasco, Wheeler, and Crook counties, was continued by A. O. Burkland, the area mapped being 240 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. None of the area mapped is within the national forest. For the control of the Twickenham quadrangle Mr. Burkland established 2 permanent bench marks by vertical angles. For the control of the Diamond Peak, Maiden Peak, Mount Washington, Disston, and McKenzie Bridge quadrangles, in Linn, Lane, Crook, Klamath, and Douglas counties, J. G. Staack and S. G. Lunde occupied and marked 14 triangulation stations.

Washington.—For the continuation of cooperative topographic surveys the Washington State Board of Geological Survey allotted $11,500, and the United States Geological Survey allotted an equal amount. The mapping of the Connell quadrangle, in Adams, Franklin, and Walla Walla counties, was completed, and that of the Walla Walla quadrangle, in Columbia and Walla Walla counties, was continued by Fred Graff, jr., R. H. Reineck, H. L. McDonald, J. L. Lewis, S. G. Lunde, and A. O. Burkland, the total area mapped being 1,391 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of the Connell, Othello, Wallula, and Red Rock quadrangles, in Franklin, Adams, Walla Walla, and Lincoln counties, D. S. Birkett ran 129 miles of primary levels and established 28 permanent bench marks.

In addition to the cooperative work in Washington, the mapping of the Mount St. Helens quadrangle, lying partly in the Rainier National Forest, in Clarke, Lewis, Cowlitz, and Skamania counties, was completed by J. L. Lewis, the area mapped being 188 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 103 square miles is within the national forest. For the control of the Mount Rainier and Eatonville quadrangles, in Pierce and Lewis counties, G. T. Hawkins ran 150 miles of primary traverse and set 15 permanent marks.

OFFICE WORK.

The drafting of the following topographic maps was completed: Paradise Valley, Idaho; St. Regis, Idaho-Mont.; Porcupine Valley, Mont.; Connell and Mount St. Helens, Wash.

The drafting of profile sheets of the following rivers was completed: Upper Salmon, Idaho; lower Swan, Mont.

Progress in the drafting of additional sheets was made as follows: Custer, Idaho, 80 per cent; Drummond, Mont., 67 per cent; Troutdale, Oreg.-Wash., 33 per cent; Twickenham, Oreg., 33 per cent; Walla Walla, Wash., 69 per cent.

Primary-level circuits were adjusted for the following quadrangles: Ammon, Bay Horse, Custer, Cranes Flat, and Shelley, Idaho; Elso, Fattig, Huntley, and Swan Lake, Mont.; Troutdale, Oreg.; Connell, Hicksville, Othello, Priest Rapids, Red Rock, and Wallula, Wash.

Geographic positions were computed for the following quadrangles: Casto, Custer, and Rabbit Foot, Idaho; Fattig, Mont.; Cline Falls, Diamond Peak, Disston, Heisler, McKenzie Bridge, Maiden Peak, Mount Washington, Round Mountain, Prineville, and Wendling, Oreg.; Connell, Eatonville, Mount Rainier, Mount St. Helens, Riparia, and Tacoma, Wash.

PACIFIC DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Arizona, California, Nevada, and Utah. This work included the completion of the survey of 25 quadrangles and 1 special area and the resurvey of 1 quadrangle and 2 special areas, in addition to which 22 quadrangles were partly surveyed and 1 was partly resurveyed. In addition, a profile survey was made of portions of three rivers, the distance traversed being 48 linear miles. Primary triangulation was carried on by two parties in Arizona, California, and Nevada.

Topographic surveys in Pacific division from July 1, 1916, to June 30, 1917.

State.	Contour interval.	For publication on scale of—						
		1:125,000 (new).	1:62,500.		1:31,680 (new).	1:24,000.		1:12,000 (resurvey).
			New.	Resurvey.		New.	Resurvey.	
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*
Arizona	25, 100	594					67	8
California	5, 25, 100	465	1,230		953			
Nevada	25, 50			355		26		
New Mexico	100	97						
Utah	50		228					
		1,156	1,458	355	953	26	67	8

State.	Total area surveyed.	Primary levels.		Triangulation stations.	
		Distance run.	Bench marks.	Occupied.	Marked.
	Sq. mi.	*Miles.*			
Arizona	669	55	13	4	3
California	2,648	690	144	80	41
Nevada	381	21	8	9	7
New Mexico	97				
Utah	228				
	4,027	766	165	93	51

Arizona.—The survey of the Chiricahua quadrangle, lying partly in the Chiricahua National Forest, in Cochise County, Ariz., and Grant County, N. Mex., was completed by J. E. Blackburn and Cornelius Schnurr, the area mapped being 468 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area, 97 square miles is within New Mexico, and 305 square miles within the national forest. The resurvey of the Oatman mining district, in Mohave County, and of Ray and vicinity, in Pinal County, was completed by B. A. Jenkins, D. H. Watson, and W. M. Beaman, the area resurveyed being 67 square miles for publication on the scale of 1:24,000 and 8 square miles for publication on the scale of 1:12,000, with a contour interval of 25 feet. For the control of the Oatman district L. F. Biggs occupied 4 triangulation stations and marked 3 and ran 53 miles of primary levels and established 13 permanent bench marks.

California.—For the continuation of cooperative topographic surveys in California the Department of Engineering allotted $14,000 and the United States Geological Survey an equal amount. In the continuation of the mapping of San Joaquin Valley the survey of the San Luis Creek, Plainsberg, Lingard, Las Garzas Creek, Bliss Ranch, Chowchilla, Volta, Berendo, Los Banos, Sandy Mush, Kismet, Turner Ranch, Elgin, Daulton, No. 10, and San Luis Ranch 7½-minute quadrangles and of the Indian Gulch 15-minute quadrangle, in Merced, Madera, Stanislaus, Fresno, and Mariposa counties, was completed by N. E. Ballmer, Roscoe Reeves, J. H. LeFeaver, R. M. Wilson, R. T. Evans, C. A. Ecklund, and E. P. Davis, the total area mapped being 1,056 square miles—909 square miles for publication on the scale of 1:31,680, with a contour interval of 5 feet, and 147 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the valley work L. F. Biggs occupied 20 triangulation stations and marked 4.

The Department of Engineering allotted an additional $1,000 for special river surveys in San Joaquin Valley. The survey of the Herndon, Friant, Kings River, No. 21, Wahtoke, Sanger, and Bridge quadrangles, in Madera and Fresno counties, was begun by R. T. Evans and C. A. Ecklund, the area mapped being 44 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of the Wahtoke and Sanger quadrangles Mr. Ecklund ran 17 miles of primary levels and established 3 permanent bench marks.

In addition to the cooperative work in California, the survey of the New Almaden, Double Point, and Point Reyes quadrangles, in Santa Clara, Santa Cruz, and Marin counties, was completed, and that of the Trimmer quadrangle, lying partly in the Sequoia and Sierra national forests, in Fresno and Tulare counties, was begun by C. A. Ecklund, R. T. Evans, J. P. Harrison, and C. P. McKinley, the total area mapped being 491 square miles—465 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet, and 26 square miles for publication on the scale of 1:62,500, with a contour interval of 25 feet. Of this area 347 square miles lies within the national forests. For the control of the Paynes Creek, Burney, Dixie, and Prattville quadrangles, in Shasta, Lassen, Plumas, and Tehama counties, C. F. Urquhart occupied 18 triangulation stations and marked 16.

Nevada.—The survey of the Rochester mining district, in Humboldt County, was completed by T. P. Pendleton, the area mapped being 26 square miles, for publication on the scale of 1:24,000, with a contour interval of 25 feet. The resurvey of the Highland quadrangle, in Lincoln County, was completed, and that of the northwest quarter of the Panaca quadrangle, in the same county, was continued by H. H. Hodgeson and W. B. Upton, jr., the area mapped being 355 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of the Rochester mining district L. F. Biggs occupied 9 triangulation stations and marked 7 and ran 21 miles of primary levels and established 8 permanent bench marks.

Utah.—The survey of the Stockton quadrangle, in Tooele County, was completed by Gilbert Young and C. R. Fisher, the area mapped being 228 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet.

OFFICE WORK.

The drafting of the following topographic maps was completed: Chiricahua and Salt River, Ariz.; Little Table Mountain, Berendo, Bliss Ranch, Lingard, Turner Ranch, Chowchilla, Sandy Mush, Plainsberg, Sulphur Springs, Le Grand, Raynor Creek, Indian Gulch, Kings River, New Almaden, Point Reyes, Double Point, La Grange, Ingomar, Kismet, San Luis Ranch, Merced Falls, Haystack Mountain, San Joaquin River, Point Sur, and Posts, Cal.; Highland and Rochester mining district, Nev.; Goodsprings, Cal.-Nev.; and Stockton, Utah.

Progress in the drafting of additional sheets was made as follows: Verde River, Ariz., 95 per cent; Daulton, Cal., 5 per cent; Elgin, Cal., 40 per cent; Los Banos, Cal., 45 per cent; No. 10, Cal., 40 per cent; Timmer, Cal., 20 per cent; northwest quarter Panaca, Nev., 62 per cent.

Level circuits were adjusted for the following quadrangles: Camp Verde and Kingman, Ariz.; Arroyo Grande, Cayucos, Jamesburg, Los Banos, Paso Robles, Sanger, San Miguel, Point Sur, and Wahtoke, Cal.; Lovelocks and Rochester mining district, Nev.

Geographic positions were computed for the following quadrangles: Oatman mining district, Ariz.; Point Sur, Jamesburg, Lucia, Metz, King City, Bradley, San Miguel, Bryson, San Simeon, Paynes Creek, Burney, Dixie, Prattville, Los Banos, Laguna Seca Ranch, No. 15, Elgin, No. 18, Mendota, No. 10, Sheep Ranch, No. 19, Center School, Firebaugh, Jamison, Dos Palos, No. 23, Kerman, Oxalis, Chaney Ranch, Carrisalito Springs, and Tranquillity, Cal.; Rochester mining district, Nev.

SECTION OF FIELD EQUIPMENT.

The section of field equipment has the custody of all field property, as well as topographic field notebooks and computation books. During the year it indexed and filed 354 triangulation and primary-traverse records and 194 spirit-leveling records. Equipment, consisting of three lathes, one drill press, 1 buffer and grinder, one universal grinder, and a few smaller tools, was ordered for the instrument-repair shop. No additions of importance were made to the stock of instruments other than the usual repair parts and supplies. In the distributing shop 159,000 square inches of plates were made, resurfaced, or electrotyped, besides usual repair work.

WATER-RESOURCES BRANCH.

ORGANIZATION.

The organization of the water-resources branch is as follows:

Chief of branch, N. C. Grover, chief hydraulic engineer.

Division of surface waters, John C. Hoyt, hydraulic engineer, in charge.

Division of ground waters, O. E. Meinzer, geologist, in charge.

Division of water utilization, N. C. Grover, chief hydraulic engineer, in charge.

Division of enlarged stock-raising homesteads, N. C. Grover, chief hydraulic engineer, in charge.

PERSONNEL.

During the year the technical force of the branch has been reduced 12 by transfers, resignations, and deaths, and has been increased 15 by new appointments. At the end of the year the force consisted of 1 chief hydraulic engineer, 12 hydraulic engineers, 4 engineers, 21 assistant engineers, 28 junior engineers, 1 geologist, 2 associate geologists, 1 assistant geologist, 1 geologic aid, 1 assistant chemist, and 1 classifier, a total of 73. Of this number 1 assistant engineer and 2 junior engineers are on furlough, and 1 hydraulic engineer and 3 assistant engineers are employed occasionally.

The following members of the water-resources branch received commissions on or prior to June 30, 1917:

A. H. Davison, Second Lieutenant, Engineer Officers' Reserve Corps.
H. J. Dean, First Lieutenant, Engineer Officers' Reserve Corps.
W. E. Dickinson, Second Lieutenant, Engineer Officers' Reserve Corps.
O. W. Hartwell, First Lieutenant, Engineer Officers' Reserve Corps.
C. C. Jacob, Captain, Engineer Officers' Reserve Corps.
G. K. Larrison, Captain, Artillery, Hawaii National Guard.
C. H. Pierce, First Lieutenant, Engineer Officers' Reserve Corps.

In the clerical force there were 4 separations and 8 accessions, and at the end of the year the force numbered 29.

ALLOTMENTS.

The appropriation for gaging streams was the same as in the preceding year ($150,000). The cooperative funds made available by State allotments have been increased in some States and decreased in others, making necessary corresponding adjustments of the work.

An appropriation of $150,000 for examination of lands under the stock-raising homestead law enacted December 29, 1916, was included in the sundry civil act approved June 12, 1917, to be immediately available.

The appropriation for gaging streams for the fiscal year was allotted as follows:

Allotments of appropriation for gaging streams (investigation of water resources), 1916–17.

Administrative expenses of the Survey		$12, 454
Administrative expenses of the branch		7, 100
Computations and reports		17, 500
Inspection		1, 000
Stream gaging:		
New England States	$4, 500	
New York	2, 500	
Virginia and Maryland	600	
South Atlantic and Gulf States	4, 500	
Texas	4, 000	
Ohio Valley	8, 000	
Upper Mississippi Valley States	6, 500	
Colorado, Wyoming, and New Mexico	7, 500	
Montana	4, 000	
Utah	4, 000	
Nevada	2, 500	
Idaho	4, 000	
Oregon	4, 000	
Washington	4, 000	
California	4, 000	
Arizona	3, 500	
Hawaii	4, 500	
		72, 600
Investigation of ground waters, including quality of waters		21, 200
Land classification board		11, 000
Water-power investigations		7, 000
Contingent		146
		$150, 000

Of the total appropriation, 62 per cent was allotted for work in public-land States.

COOPERATION.

States.—Cooperative funds were allotted by several States as follows:

Amounts allotted by States for cooperative work with United States Geological Survey in investigation of water resources.

Alabama		$175
Arizona		4, 040
California:		
State engineer	$8, 280	
State water commission	6, 835	
City of San Francisco	4, 380	
		19, 495

Colorado		$530
Connecticut		770
Hawaii		16,000
Illinois		2,580
Iowa		500
Kansas		1,000
Kentucky		420
Maine		5,640
Massachusetts		2,370
Minnesota		2,470
Mississippi		550
Montana		2,760
Nevada		1,980
New York:		
State engineer	$1,500	
Conservation commission	9,835	
		11,335
North Dakota		300
Oregon		5,700
Texas		10,295
Utah		5,180
Vermont		1,245
Washington		6,230
Wisconsin		5,970
Wyoming		4,895

The work done under cooperative agreements with the States has been restricted to studies of stream flow except in California, Connecticut, Arizona, Montana, and Hawaii.

In California investigations of ground waters were continued in San Jacinto, Salinas, and Santa Clara valleys and in San Diego County, and measurements of depth to ground-water level were made in the southern part of the State.

The report on ground water in Sacramento Valley, work on which has been in progress for several years, was practically completed, and the report on the San Jacinto and Temecula basins and a special report on floods in southern California in January and February, 1916 (Water-Supply Paper 426), were submitted for publication.

In Connecticut the cooperative work consisted chiefly of ground-water surveys.

In Hawaii measurements of streams were supplemented by measurements of precipitation and studies of the loss of water in irrigation canals.

A compilation of stream-flow records in Massachusetts, which was in press at the beginning of the fiscal year, was issued as Water-Supply Paper 415, and a similar compilation of stream-flow records in Vermont is in press as Water-Supply Paper 424.

Investigations of ground water in Arizona were continued as in previous years in cooperation with the Agricultural Experiment Station, analyses of water being made at the experiment station.

An investigation of ground waters in Montana, begun in 1916 in cooperation with the State engineer, who collected well records throughout the State, and with the State Board of Health and Montana State College, at the chemical laboratory of which analyses of water were made, was also continued.

Reclamation Service.—The measurement of streams that are to furnish water to reclamation projects under construction has been continued in cooperation with the United States Reclamation Service. The field work is done by Survey engineers who are employed in the locality, and actual cost is repaid by the Reclamation Service through transfer of funds.

The Survey also continued to assist the Reclamation Service in an investigation undertaken to obtain a basis for the equitable distribution of the waters of Milk and St. Mary rivers—a work carried on under cooperative agreement with the Canadian Department of the Interior.

Office of Indian Affairs.—In accordance with authorizations by the Office of Indian Affairs, stream gaging was continued on the following Indian reservations: Colville, Crow, Fort Hall, Klamath, La Pointe, Menominee, Pine Ridge, Quinault, Rosebud, Standing Rock, Warm Springs, and Western Shoshone.

National Park Service.—Streams in the Yosemite, Glacier, and Yellowstone national parks were measured during the year at stations maintained in cooperation with the National Park Service.

War Department.—Stream measurements made in connection with studies of flood control and navigation in the Ohio River basin have been continued in cooperation with the Corps of Engineers, United States Army.

Reports on both surface and ground waters available for use at cantonments and other sites of military importance were prepared and submitted to the War Department.

Forest Service.—A study of stream flow in the Angeles National Forest, in southern California, in cooperation with the Forest Service, was continued.

City of San Francisco.—In connection with the proposed storage of the water of Tuolumne River in Hetch Hetchy Valley as a water supply for the city of San Francisco, measurement of that stream was continued in cooperation with the city government.

City of San Diego.—An investigation of the ground water in the part of San Diego County lying west of the divide was nearly completed. In this work the San Diego city government cooperated.

PUBLICATIONS.

The publications of the year prepared by the water-resources branch comprise 25 reports and 5 separate chapters. Titles and brief summaries of these publications are given on pages 26–30. At the end of the year 22 other reports were in press and 8 manuscripts were awaiting editorial examination.

GENERAL SUMMARY.

In the investigation of surface waters the water-resources branch has maintained gaging stations for measuring discharge of streams in 41 States and in Hawaii and Alaska. The relatively large amount of work now in progress is, however, possible only because of extensive cooperation with States and other Federal organizations. Twenty-four cooperating States (including Hawaii) have contributed more than $110,000 for work in these States, and the Indian Office, Engineer Corps, Reclamation Service, and Forest Service have also cooperated largely in the study of flow of particular streams. The cooperating States include, besides many of the northern and eastern States, all the States in the Great Basin and on the Pacific slope and nearly all those in the Rocky Mountain and western Gulf groups, where water is necessary for irrigating agricultural lands.

Ground-water investigations have been made in 14 States and in Alaska, and five water-supply papers containing the results of such investigations have been published during the year.

Many investigations of ground water or quality of water were under way at the end of the year, but lack of funds prevents an enlargement of the work commensurate with the importance of the subject.

Many investigations of the present and probable future use of both surface and ground waters have been made in connection with the classification of the public lands, with special reference to their use for power, under permit, or for agriculture, under the enlarged-homestead, desert-land, or Carey acts. The results of such investigations are generally incorporated in unpublished special reports to the Commissioner of the General Land Office and to the Secretary of the Interior.

DIVISION OF SURFACE WATERS.

ORGANIZATION.

The work of the division of surface waters consists primarily of the measurement of the flow of rivers. In includes also special investigations of conditions affecting stream flow and the utilization of streams. In carrying on the work the United States is divided into 17 districts, including Hawaii. One of these districts (Kansas) was established during the year. The following list shows the location of the districts and district offices and gives the names of the engineers:

New England: C. H. Pierce, Customhouse, Boston, Mass.
New York: C. C. Covert, Federal Building, Albany, N. Y.
Middle Atlantic: G. C. Stevens, Washington, D. C.

South Atlantic and eastern Gulf: W. E. Hall, Federal Building, Atlanta, Ga.
Ohio River: A. H. Horton, Washington, D. C.
Upper Mississippi River: W. G. Hoyt, Capitol Building, Madison, Wis.; suboffices, Old Capitol Building, St. Paul, Minn.; Federal Building, Chicago, Ill.
Kansas: R. C. Rice, Federal Building, Topeka, Kans.
Upper Missouri: W. A. Lamb, Montana National Bank Building, Helena, Mont.
Rocky Mountain: Robert Follansbee, New Post Office Building, Denver, Colo.
Great Basin: C. C. Jacob, Federal Building, Salt Lake City, Utah.
Idaho: G. C. Baldwin, Idaho Building, Boise, Idaho.
Washington: G. L. Parker, Federal Building, Tacoma, Wash.
Oregon: F. F. Henshaw, Couch Building, Portland, Oreg.
California: H. D. McGlashan, Customhouse, San Francisco, Cal.; suboffice, Federal Building, Los Angeles, Cal.
Arizona: C. E. Ellsworth, Fleming Building, Phoenix, Ariz.
Texas: G. A. Gray, Old Post Office Building, Austin, Tex.
Hawaii: G. K. Larrison, Kapiolani Building, Honolulu, Hawaii.

CHARACTER AND METHODS OF WORK.

Field investigations incident to the work are made from the district offices, where the results are sufficiently analyzed to insure their accuracy and completeness. At selected places, known as gaging stations, measurements of discharge are made and other data are collected, from which the daily flow of the streams is computed. At the end of the year 1,178 gaging stations were being maintained, including 92 in Hawaii. During the year 259 stations were discontinued and 144 stations established. In addition records ready for publication were received for about 150 stations from other Government bureaus and private persons. During the year 7,769 measurements of discharge were made. Many of the stations are maintained in cooperation with other Federal bureaus, State organizations, or individuals.

Gaging stations and cooperating parties for the year ended June 30, 1917.

State.	Geological Survey alone.	Reclamation Service.	Forest Service.	Indian Service.	Army Engineers.	Weather Bureau.	Other Federal bureaus.	State cooperation.	Municipal cooperation.	Private persons.	Counted more than once.	Maintained at end of year.	Established during year.	Discontinued during year.	Regular gagings during year.	Miscellaneous gagings during year.
Alabama	....	....	....	....	1	....	....	4	....	....	....	5	....	....	6	....
Arizona	....	1	....	6	2	....	....	18	....	2	5	24	3	2	266	61
California	....	....	29	2	....	2	6	151	23	42	104	151	21	17	1,207	379
Colorado	4	3	20	....	....	1	....	14	....	6	1	47	6	6	244	6
Connecticut	....	....	....	....	....	....	....	....	....	1	....	1	....	1	11	....
Florida	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	11
Georgia	2	....	....	....	....	4	....	....	....	18	2	22	4	3	53	9
Idaho	2	18	2	15	....	1	....	6	....	9	7	46	11	35	323	50
Illinois	....	....	....	....	1	1	....	25	....	1	2	26	3	1	93	1
Indiana	....	....	....	....	....	....	....	....	....	1	....	1	....	1	....	....
Iowa	....	....	....	....	....	3	....	14	....	....	3	14	1	1	42	1
Kansas	....	....	....	....	....	....	....	3	....	....	....	3	3	....	4	....
Kentucky	....	....	....	....	....	....	....	5	....	....	....	5	....	....	20	1
Maine	....	....	....	....	....	....	....	16	....	2	2	16	....	....	115	....
Maryland	3	....	....	....	....	....	....	....	....	....	....	3	....	....	10	....
Massachusetts	....	....	....	....	....	....	....	17	....	1	1	17	....	....	143	2
Michigan	....	....	....	....	....	....	....	....	1	1	....	2	....	....	....	....
Minnesota	....	....	....	....	1	2	....	29	....	1	4	29	2	3	147	1

Gaging stations and cooperating parties for the year ended June 30, 1917—Continued.

State.	Geological Survey alone.	Reclamation Service.	Forest Service.	Indian Service.	Army Engineers.	Weather Bureau.	Other Federal bureaus.	State cooperation.	Municipal cooperation.	Private persons.	Counted more than once.	Maintained at end of year.	Established during year.	Discontinued during year.	Regular gagings during year.	Miscellaneous gagings during year.
Montana	8	35	14	7	....	1	....	23	....	1	1	88	8	30	445	10
Nevada	....	2	....	3	....	1	....	34	....	12	18	34	3	11	118	22
New Hampshire	....	....	....	....	....	....	....	......	....	6	......	6	2	......	20	2
New Jersey	1	....	....	....	....	....	....	......	....	......	......	1	......	......	1	......
New Mexico	1	....	....	....	....	....	....	......	....	3	......	4	......	3	20	......
New York	....	....	....	....	1	4	....	48	1	18	24	48	7	10	431	16
North Carolina	1	....	....	....	....	1	....	......	....	3	......	5	......	4	21	......
North Dakota	....	....	....	1	....	....	....	5	....	......	......	6	......	......	30	......
Ohio	1	....	....	....	2	....	....	......	....	......	......	3	......	3	2	......
Oklahoma	....	4	....	....	....	....	....	......	....	......	......	4	......	......	2	......
Oregon	....	4	3	9	....	2	1	15	18	54	......	106	25	38	286	81
Rhode Island	....	....	....	....	....	....	....	......	....	......	......	......	......	1	4	......
South Carolina	....	....	....	....	....	....	1	......	....	......	......	1	......	......	3	......
South Dakota	....	....	....	4	....	....	....	......	....	1	......	5	......	......	29	2
Tennessee	....	....	....	....	....	2	....	......	....	6	......	8	1	1	40	4
Texas	....	1	....	....	....	4	....	39	4	2	11	30	7	1	367	16
Utah	....	2	....	5	....	....	....	118	....	89	96	118	17	23	881	122
Vermont	....	....	....	....	....	....	....	9	....	4	4	9	......	......	37	2
Virginia	2	....	....	....	....	1	....	......	....	2	......	5	......	5	25	1
Washington	3	1	8	13	....	....	1	7	2	30	1	64	6	3	360	63
West Virginia	8	....	....	....	6	1	....	......	....	2	......	17	......	25	52	2
Wisconsin	....	....	....	2	2	....	....	45	1	11	16	45	4	3	229	5
Wyoming	....	5	2	....	....	1	3	49	....	1	3	58	3	13	220	5
Hawaii	....	....	....	....	2	....	....	92	....	45	47	92	7	15	542	45
	36	76	78	67	18	32	12	786	50	375	352	1,178	144	259	6,849	920

Data collected from the district offices are transmitted to the Washington office, where they are reviewed in the computing section and prepared for publication. This review insures accuracy in the data and brings the results from different parts of the country to a uniform standard. Regular field inspections are made, and through annual conference of the engineers the work in the several districts is further standardized.

PUBLICATIONS.

For convenience and uniformity in publication the United States has been divided into 12 primary drainage basins, and the results of stream measurements are published annually in a series of progress reports that correspond to these 12 divisions. Prior to 1914 the records for each division were contained in a single water-supply paper; since 1914 the reports for the twelfth division have been published as three papers.

In addition to the progress reports, special reports on various hydraulic subjects have been completed for publication during the year.

The following table shows the division into drainage areas and gives numbers of water-supply papers containing results of stream measurements for 1899–1917:

Numbers of water-supply papers containing results of stream measurements, 1899–1917.

Year.	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
												North Pacific slope basins.		
	North Atlantic slope (St. John River to York River).	South Atlantic and eastern Gulf of Mexico (James River to the Mississippi).	Ohio River.	St. Lawrence River and Great Lakes.	Hudson Bay and upper Mississippi River.	Missouri River.	Lower Mississippi River.	Western Gulf of Mexico.	Colorado River.	Great Basin.	Pacific slope in California.	Pacific slope in Washington and upper Columbia River.	Snake River basin.	Lower Columbia River and Pacific slope in Oregon.
1899 [a]	35	[b] 35, 36	36	36	36	[c] 36, 37	37	37	[d] 37, 38	38, [e] 39	38, [f] 39	38	38	38
1900 [g]	47, [h] 48	48	48, [i] 49	49	49	49, [j] 50	50	50	50	51	51	51	51	51
1901	65, 75	65, 75	65, 75	65, 75	[k] 65, 66, 75	66, 75	[k] 65, 66, 75	66, 75	66, 75	66, 75	66, 75	66, 75	66, 75	66, 75
1902	82	[b] 82, 83	83	[l] 82, 83	[k] 83, 85	84	[k] 83, 84	84	85	85	85	85	85	85
1903	97	[b] 97, 98	98	97	[k] 98, 99, [m] 100	99	[k] 98, 99	99	100	100	100	100	100	100
1904	[n] 124, [o] 125, [p] 126	[p] 126, 127	128	129	[k] 128, 130	130, [q] 131	[k] 128, 131	132	133	133, [r] 134	134	135	135	135
1905	[n] 165, [o] 166, [p] 167	[p] 167, 168	169	170	171	172	[k] 179, 173	174	175, [s] 177	176, [r] 177	177	178	178	[t] 177, 178
1906	[n] 201, [o] 202, [p] 203	[p] 203, 204	205	206	207	208	[k] 205, 209	210	211	212, [r] 213	213	214	214	214
1907–8	241	242	243	244	245	246	247	248	249	250, [r] 251	251	252	252	252
1909	261	262	263	264	265	266	267	268	269	270, [r] 271	271	272	272	272
1910	281	282	283	284	285	286	287	288	289	290	291	292	292	292
1911	301	302	303	304	305	306	307	308	309	310	311	312	312	312
1912	321	322	323	324	325	326	327	328	329	330	331	332–A	332–B	332–C
1913	351	352	353	354	355	356	357	358	359	360	361	362–A	362–B	362–C
1914	381	382	383	384	385	386	387	388	389	390	391	392	393	394
1915	401	402	403	404	405	406	407	408	409	410	411	412	413	414
1916	431	432	433	434	435	436	437	438	439	440	441	442	443	444
1917	451	452	453	454	455	456	457	458	459	460	461	462	463	464

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[a] Rating tables and index to Water-Supply Papers 35–39 contained in Water-Supply Paper 39. Estimates for 1899 in Twenty-first Annual Report, Part IV.

[b] James River only.

[c] Gallatin River.

[d] Green and Gunnison rivers and Grand River above junction with Gunnison.

[e] Mohave River only.

[f] Kings and Kern rivers and south Pacific slope basins.

[g] Rating tables and index to Water-Supply Papers 47–52 and data on precipitation, wells, and irrigation in California and Utah contained in Water-Supply Paper 52. Estimates for 1900 in Twenty-second Annual Report, Part IV.

[h] Wissahickon and Schuylkill rivers to James River.

[i] Scioto River.

[j] Loup and Platte rivers near Columbus, Nebr., and all tributaries below junction with Platte.

[k] Tributaries of Mississippi from east.

[l] Lake Ontario and tributaries to St. Lawrence River proper.

[m] Hudson Bay only.

[n] New England rivers only.

[o] Hudson River to Delaware River, inclusive.

[p] Susquehanna River to Yadkin River, inclusive.

[q] Platte and Kansas rivers.

[r] Great Basin in California except Truckee and Carson river basins.

[s] Below junction with Gila.

[t] Rogue, Umpqua, and Siletz rivers only.

DIVISION OF GROUND WATERS.

SCOPE OF WORK.

The work of the division of ground waters comprises investigations of the occurrence and quality of waters below the surface of the ground and of methods of recovering and utilizing such waters. Most of the work has been done in the arid and semiarid States of the West, where interest in irrigation with ground water is great and where prospects for considerable increase in areas thus irrigated are favorable.

Nearly 40 investigations of ground water or quality of water (including the reports in press) were in progress in the course of the year, covering areas in Alaska, Arizona, California, Connecticut, Mississippi, Montana, Nebraska, Nevada, New Mexico, South Carolina, South Dakota, Texas, Utah, Washington, and Wyoming. Of these investigations six were conducted in cooperation with the geologic branch of this Survey, one was made for the War Department, one for the Department of Justice, one for the United States Indian Office, and 19 were made in cooperation with State organizations, including two geological and natural history surveys, two departments of engineering, two experiment stations, one agricultural college, and one board of health.

During the year the division suffered a severe loss in the death of R. B. Dole, whose thorough and extensive work on the quality of the natural waters of the United States during his 14 years of service on the Geological Survey constitutes an eminent contribution to science and a production of great economic value to the entire country. The comprehensive paper which he was preparing on the chemical composition of the surface waters of the United States remains unfinished, but it is to be completed by other workers and eventually to be published as a professional paper. A. A. Chambers has been placed in charge of the investigations of the quality of water.

In connection with preparations for war a comprehensive digest of information relating to the water supplies available for use at military camps near the border of the United States, except the Canadian border, was prepared in cooperation with the section of Coastal Plain investigations of the geologic branch and was submitted to the War Department.

A bibliography of the publications of the United States Geological Survey relating to ground water, with brief abstracts, detailed index, and map, was prepared by O. E. Meinzer and is to be published as a water-supply paper. Work was also begun by Mr. Meinzer on a comprehensive treatise on ground water and on an elaborate report on the geology and water resources of the desert valleys of the western United States.

A paper entitled "The divining rod, a history of water witching, with a bibliography," by A. J. Ellis, was published as Water-Supply Paper 416. The chapter on the production of mineral waters for the annual volume, Mineral Resources of the United States, also was prepared by Mr. Ellis.

The analytical work in connection with studies of oceanography, begun in a previous year, was continued by A. A. Chambers. A brief report was prepared by Mr. Chambers on the mineral waters of the United States as compared with those formerly imported from Europe. A paper on the classification of springs was prepared by Kirk Bryan and will be published as part of the "Contributions to hydrology."

As in previous years the maps and manuscripts for geologic folios were reviewed so far as they relate to ground water.

Meetings of the Ground-Water Club for professional study and discussion were held biweekly during the winter and spring.

WORK BY STATES.

Alaska.—The report on the mineral springs of Alaska, by G. A. Waring, with a chapter on the quality of the water by R. B. Dole and A. A. Chambers, was submitted for publication as Water-Supply Paper 418. Analyses of Alaska surface waters have also been made by Mr. Chambers, and a report on these is in preparation.

Arizona.—The report on "The Navajo country, a geographic and hydrographic reconnaissance of parts of Arizona, New Mexico, and Utah," by H. E. Gregory, was published as Water-Supply Paper 380. A brief report on ground water in an area west of Little Colorado River is being prepared by Prof. Gregory. Both reports are based on investigations made in previous years through financial cooperation by the Office of Indian Affairs.

A report by A. T. Schwennesen on the artesian and other ground waters in San Simon Valley, with special reference to their use for irrigation, was published as Water-Supply Paper 425–A. A comprehensive report on ground water in San Bernardino and San Simon valleys and in Gila Valley above San Carlos is being prepared. Through cooperation with the Arizona Agricultural Experiment Station the water analyses in connection with these investigations were made by A. E. Vinson, of the experiment station staff.

Near the end of the fiscal year plans were made for a comprehensive survey of desert watering places and conditions affecting the occurrence of ground water in that part of Arizona lying west of Tucson and south of Phoenix and Parker. Kirk Bryan and C. P. Ross were assigned to this project.

California.—The report on ground water in the San Jacinto and Temecula basins, Cal., was completed by G. A. Waring and is to be published as a water-supply paper.

A detailed report on the ground water in the part of San Diego County lying west of the divide, by A. J. Ellis and C. H. Lee, was nearly completed. The analytical work for this investigation was done by S. C. Dinsmore. Financial cooperation was furnished by the city of San Diego.

Some work was done on the final report on Sacramento Valley by Kirk Bryan, but the completion of this paper was delayed through the author's duties in connection with Yale University.

A report on ground water in the Morgan Hill area of Santa Clara Valley, by W. O. Clark, was completed and published as Water-Supply Paper 400–E. The final report on the entire Santa Clara Valley was nearly completed by the end of the fiscal year.

Brief investigations of ground water in Mohave Valley and in Ivanpah, Mesquite, and Pahrump valleys were made by G. A. Waring, who practically completed his reports on all these valleys. The analytical work in connection with these investigations was done by S. C. Dinsmore.

An investigation of Salinas Valley was begun by W. O. Clark, and at the end of the fiscal year most of the field work in this area was completed.

Near the end of the year plans were made for a detailed survey of desert watering places and ground-water resources of parts of southeastern California, including Imperial Valley, Colorado Desert, Mohave Desert, and Death Valley. Field work in this region was assigned to D. G. Thompson and J. S. Brown.

Since 1900 measurements of depth to water level in a series of wells in southern California have been made at intervals, for the purpose of obtaining a record through many years of the relation between the contributions to the underground reservoirs in the rainy seasons and the withdrawals from them in the dry seasons, when ground water is pumped for irrigation and is withdrawn in large quantities by evaporation and transpiration. As in the preceding year, these measurements were made by F. C. Ebert.

All the ground-water work in California is done in financial cooperation with the State department of engineering.

Connecticut.—Observations in connection with an investigation of the relations between precipitation, ground-water storage, evaporation, run-off, and quality of water in the Pomperaug Valley, begun in July, 1913, by A. J. Ellis, were continued during the year, and some work was done in compiling the results.

Reports, which will be published as water-supply papers, were also practically completed for the Meriden area, the Southington-Granby area, the Glastonbury area, the Norwalk area, and the Suffield area. The Meriden report is by G. A. Waring; the others by H. S. Palmer. A total of 127 samples of water from the Meriden and Southington-Granby areas were analyzed by Messrs. Dinsmore and Chambers.

All the work in Connecticut was done in cooperation with the State Geological and Natural History Survey and was supervised by H. E. Gregory.

Mississippi.—The investigation of ground water in Mississippi, which was begun in a previous year, was continued in cooperation with the section of Coastal Plain investigations of the geologic branch. (See p. 64.)

A chapter on the water in the Eocene formations was prepared by Mr. Waring, and considerable work was done on a study of the quality of water in the State by Mr. Chambers.

Montana.—The investigation of ground water in Montana, begun in August, 1915, was continued by A. J. Ellis, who nearly completed a report on the entire area south of Yellowstone River. This investigation is carried on in cooperation with State organizations. The chemical analyses are made at the laboratory of the State board of health and the Montana State College, under the supervision of W. M. Cobleigh, director of the laboratory, and records of wells are collected throughout the State by A. W. Mahon, State engineer, in cooperation with W. A. Lamb, district engineer of the United States Geological Survey.

A report by O. E. Meinzer on artesian water in Little Bitterroot Valley, with special reference to its use for irrigation, was published as Water-Supply Paper 400–B. The report contains 10 analyses, made in the laboratory of the State board of health and Montana State College, of water from this valley.

Nebraska.—A report on the ground-water supplies available for irrigation in Lodgepole Valley, Nebr., was prepared by O. E. Meinzer and submitted for publication as Water-Supply Paper 425–B. This paper includes also a section on the cost of pumping for irrigation in western Nebraska, by H. C. Diesem, of the Office of Public Roads and Rural Engineering, Department of Agriculture.

Nevada.—The final report on ground water in Big Smoky, Clayton, and Alkali Spring valleys, by O. E. Meinzer, was published as Water-Supply Paper 423. The water-level measurements begun in 1913 were continued during the year by F. J. Jones.

The investigation of ground water on the Truckee-Carson irrigation project, to determine the cause of the rise of the water levels in

Big Soda and Little Soda lakes, by C. H. Lee and W. O. Clark, was completed, and a report thereon was submitted to the Department of Justice.

An investigation of the ground-water resources of Reese River valley and an adjacent part of Humboldt River valley was made by G. A. Waring, who prepared a report on the area to be published as a part of Water-Supply Paper 425. The area examined by Mr. Waring in Ivanpah, Mesquite, and Pahrump valleys also lies in part in the State of Nevada. Water analyses for both areas were made for the Geological Survey by S. C. Dinsmore at Reno, Nev.

New Mexico.—A report on ground water in the Animas, Playas, Hachita, and San Luis basins, in Grant County, N. Mex., completed by A. T. Schwennesen in the preceding fiscal year, is to be issued as Water-Supply Paper 422. Analyses of water samples and of the water-soluble contents of soil samples from these basins were made by R. F. Hare through cooperation with the New Mexico Agricultural Experiment Station.

The Navajo country, which was investigated by H. E. Gregory, and San Simon Valley, which was investigated by A. T. Schwennesen, lie partly in New Mexico but more largely in Arizona. Reports on both areas were published during the fiscal year.

An investigation to determine the changes produced in the artesian basin in Pecos Valley through developments since 1906, when a preliminary report on the geology and underground waters of the Roswell artesian area by C. A. Fisher (Water-Supply Paper 158) was published, and to devise means for ascertaining and preventing the underground losses of artesian water was made by O. E. Meinzer, who spent about ten days in the field and submitted a manuscript report to the land-classification board.

South Carolina.—Near the end of the fiscal year a survey of the ground-water resources of the Coastal Plain province of South Carolina (see p. 74) was begun in cooperation with the section of Coastal Plain investigations of the geologic branch. Water samples collected in connection with this investigation are being sent to the new water laboratory of the Geological Survey to be analyzed under the direction of Mr. Chambers.

South Dakota.—A report on artesian water in the vicinity of the Black Hills, S. Dak., prepared in the preceding fiscal year by N. H. Darton, is still awaiting publication. This report is a revision of earlier reports on the area by Mr. Darton and includes much new material.

Texas.—The work in Texas was done in cooperation with the section of Coastal Plain investigations of the geologic branch. Work was continued in the part of the Texas Coastal Plain not covered by Water-Supply Paper 335 (Geology and underground waters of the southeastern part of the Texas Coastal Plain, by Alexander Deussen), and a comprehensive paper on this area is being prepared.

Utah.—A rapid examination of parts of western Utah was made by G. A. Waring for the purpose of obtaining information for the classification of lands under the enlarged-homestead act. A manuscript report was submitted by Mr. Waring to the land-classification board.

Washington.—Ground-water conditions in Quincy Valley, Wash., including the Moses Lake region, were investigated in the fall of 1916 by A. T. Schwennesen, who prepared a report on the area which will be published as Water-Supply Paper 425–E. This investigation is important because of the need for water to irrigate orchard lands. Twenty samples of water from the area were analyzed by S. C. Dinsmore.

Wyoming.—A report on ground water for irrigation in Lodgepole Valley, which lies partly in Wyoming and partly in Nebraska, was prepared by O. E. Meinzer and is now in press as Water-Supply Paper 425–B.

DIVISION OF WATER UTILIZATION.

The organization of the division of water utilization was continued during the year essentially as described in previous annual reports, except that the force was increased by the transfer from the Salt Lake office of W. E. Dickinson. E. C. La Rue, to whom Mr. Dickinson was assigned as an assistant, and E. C. Murphy, hydraulic engineer, have done the greater part of the field work involved in the examination of water-power withdrawals, rights of way, and Carey Act segregations. Mr. La Rue completed his report on enlarged-homestead petitions near Utah Lake and in the last part of August established headquarters at Portland, Oreg., from which he engaged in office and field examination of lands that will revert to the United States from the grant to the California-Oregon Railroad Co. In connection with this work, Mr. La Rue has submitted a report on the Rogue River basin and begun the preparation of reports on the basins of Willamette and Big Sandy rivers and coast streams. These reports are being prepared for the purpose of determining the value of streams on the railroad-grant lands for the development of power.

Mr. Murphy completed his report on water-power sites in New Mexico and then began an investigation of enlarged-homestead petitions in Montana. During the year he examined lands in the basins of Teton, Marias, Missouri, Sun, Dearborn, and Boulder rivers, and Whitetail and Clancy creeks, along Musselshell River, in the Musselshell irrigation district, in the basin of American Fork, on the Winnett irrigation project, and on the Flat Willow project.

Reports containing the results of work of the division of water utilization published during the year include Water-Supply Papers 395, 396, 417, 419, 420, and 421. Titles and brief summaries of these publications are given on pages 28 and 30.

DIVISION OF ENLARGED AND STOCK-RAISING HOMESTEADS.

The funds for the administration of the stock-raising homestead law became available June 12 on the approval of the sundry civil appropriation act, which also provided specifically for the cost of classifying enlarged-homestead lands, an expense that had previously been borne by the general appropriation for investigations of water resources. E. C. Murphy, hydraulic engineer, who had been examining enlarged-homestead lands in Montana, was immediately assigned to field work in Montana under the new law and was still engaged in that work at the end of the fiscal year.

In anticipation of the urgent necessity for a large number of men for field service in classifying lands under the new law, the Civil Service Commission had given a special examination and established a small list of eligibles. Work on the organization of field parties was in progress June 30, but no field work had been done.

LAND-CLASSIFICATION BOARD.

ORGANIZATION AND PERSONNEL.

The land-classification board consists of a division of mineral classification, the work of which pertains to lands valuable for coal, oil, phosphate, and various other minerals, and a division of hydrographic classification, the work of which pertains to irrigation, dry farming, stock raising, and water power. Technical men from other branches of the Survey act in consultation on matters involving important classification. The organization and personnel for the year were as follows:

Chief of branch: W. C. Mendenhall, geologist.

Secretary of the board: Elsie Patterson.

Division of mineral classification: A. R. Schultz, geologist; E. R. Lloyd and E. H. Finch, associate geologists; W. B. Emery, R. W. Howell, and H. S. Palmer, assistant geologists; Howard Clark, junior topographer.

Division of hydrographic classification: Herman Stabler, hydraulic engineer; W. B. Heroy, geologist; R. W. Davenport and R. M. Davis, assistant engineers; W. N. White, assistant classifier; J. F. Deeds, J. G. Mathers, and M. A. Sanchez, junior engineers; C. E. Nordeen, junior topographer.

The permanent force of the board at the end of the year included 6 geologists, 8 engineers, 4 draftsmen, and 24 employees in other grades, a total of 42 persons. There were 15 additions to and 10 separations from the force during the year.

FUNDS.

The allotments from the different appropriations amounted for the year 1917 to $57,120 and were distributed among the general appropriations as follows:

Geologic surveys	$29,720
Topographic and forest surveys	11,500
Gaging streams	11,000
Salaries of scientific assistants and skilled labor	4,900
	57,120

SUMMARY OF WORK OF CLASSIFICATION.

During the year 1,321,989 acres of lands were classified as to their coal character. Of this amount 951,540 acres were classified as noncoal land and 370,449 as coal land. Coal-land withdrawals during the year amounted to 553,233 acres, and coal-land restorations to 1,635,446 acres. The area withdrawn for classification as to coal at the close of the year was 44,853,741 acres.

New withdrawals of probable oil lands amounting to 903,791 acres were made during the year, and areas aggregating 176,311 acres were restored because examination determined that the lands were not favorable for the accumulation of oil. The result of the year's work, therefore, has been an increase of the area of oil reserves from 5,621,160 to 6,348,640 acres. Indian lands to the amount of 42,097 acres were classified as oil lands.

The classification of 2,530,309 acres of land as mineral land because they contain shales from which, it is believed, great quantities of petroleum and by-products may be distilled brings the total area of lands so classified up to 3,992,036 acres. Naval reserves of such oil-shale land aggregating 132,024 acres were established during the year.

Phosphate reserves were decreased by 80 acres during the year, the area withdrawn on June 30, 1917, being 2,506,398 acres.

During the year the Secretary, on the recommendation of the Geological Survey, designated 13,133,851 acres of land as nonirrigable under the enlarged-homestead acts. The designations of 112,807 acres, which were found to have been erroneously designated, were canceled, the result being a net increase in this classification of lands of a little more than 13,000,000 acres during the year. At the end of the year 275,633,861 acres were classified as being not susceptible of irrigation. The number of petitions for such designation available for action during the year was 16,077, of which 8,868 were acted upon; 7,209 were awaiting action at the end of the year.

Withdrawals of lands believed to be available for power sites aggregated 156,353 acres, and restorations of lands previously withdrawn but found to be without value for power amounted to 79,908 acres. The increase of outstanding withdrawals from 2,352,652 to 2,429,097 acres was the net result of these actions. In pursuance of the enabling act 764,438 acres in Arizona and 201,000 acres in New Mexico were designated as valuable for water power, and 31,765 acres of Oregon & California Railroad grant lands in Oregon were classified as power-site lands.

During the year areas amounting to 11,934 acres were withdrawn as public water reserves and 3,498 acres were eliminated from such reserves. The net increase in lands withdrawn as public watering places was from 193,272 to 201,708 acres.

CORRESPONDENCE.

During the year 25,721 letters were referred to the land-classification board. In addition, some 4,900 copies of correspondence from various bureaus were sent to the board for its information and files. This material is made up largely of copies of General Land Office letters to registers and receivers of local land offices, of reports made by agents of the General Land Office, and of copies of departmental decisions. In the same period 15,362 letters, reports, acknowledgments, and notifications were prepared in the board. For the working days of the year these figures show a daily average of about 85 for the incoming and 51 for the outgoing mail.

PUBLICATIONS.

Bulletin 623, entitled "Petroleum withdrawals and restorations affecting the public domain," was made available to the public in June, 1916. The demand for this report was so large that the entire edition was exhausted in less than four months, and a reprint was ordered in October, 1916. At the same time an appendix to the first edition of this bulletin was printed, covering all the oil withdrawals and restorations made from January 15 to September 30, 1916. A copy of this appendix was mailed to each person who had received a copy of Bulletin 623. The reprint of this bulletin, which includes the appendix, gives true copies of all petroleum withdrawals and restorations, contains chapters on the purpose and history of withdrawals, oil-land law, and orders and correspondence, and is illustrated by nine State maps showing all lands included in withdrawals on September 30, 1916. Additional withdrawals and restorations have been made in some of the States since that date, and lists have been published in Press Bulletin 321 and in a multigraphed circular. It is planned to make future similar actions available to the public in the same manner and by the issue of revised reprints or appendixes to Bulletin 623.

COOPERATION WITH THE GENERAL LAND OFFICE.

The cooperation between the General Land Office and the Geological Survey, by which the Survey's information on the mineral and power value of lands sought under the public-land laws is made available to the department through the Land Office, was continued along the same lines as in 1915–16. The Survey received during the year 3,067 requests from the General Land Office for information as to the mineral character or the relation to water supply of public lands sought, and it furnished such information in 3,651 cases. It also received for consideration 1,372 reports of field examinations by the General Land Office and acted on 1,314 reports of this character.

At the beginning of the year more than 2,000 cases involving the mineral character of lands were pending, and at the end of the year the number was about 500 less. The cases acted upon involving both mineral character and water resources also outnumber the cases received, and the pending cases of this class at the end of the year were about 700 less in number than at the beginning. The total number of cases covered by the cooperative agreement with the General Land Office pending at the end of the year is 1,585, approximately 500 less than at the beginning of the year. Of the pending cases, 486 are concerned only with the mineral character of the land, 24 only with the water resources, and 1,075 with both mineral character and water resources.

During the year numerous applications for classification of lands included in withdrawals were received. A number of requests were sent to the Survey for the reclassification of lands as to mineral or power-site possibilities, and a large number of applications of other types were referred for consideration and report. These are considered in more detail in the sections on hydrographic and mineral classifications.

The following table shows the year's record in the several classes of cooperative cases, including those discussed above and including also requests for the designation of lands under the enlarged-homestead and stock-raising homestead acts and other miscellaneous cases:

General summary of cooperative cases, fiscal year 1916–17.

Class.	Pending July 1, 1916.	Received.	Disposed of.	Pending June 30, 1917.	Gain or loss.
ineral character only:					
General Land Office requests for information	90	425	455	60	+ 30
General Land Office field-service reports	199	949	722	426	− 227
Applications for classification as to mineral	18	76	56	38	− 20
	307	1,450	1,233	524	− 217
ater resources only:					
General Land Office requests for information	30	22	46	6	+ 24
General Land Office field-service reports	20	24	26	18	+ 2
Cases in national forests	1	24	19	6	− 5
Applications for reclassification as to water resources	12	78	72	18	− 6
Applications for rights of way	98	321	347	72	+ 26
Lists under Carey Act	1	4	5	0	+ 1
Desert-land proofs under irrigation projects	51	87	72	66	− 15
Petitions under enlarged-homestead acts	7,038	9,039	8,868	7,209	− 171
Applications under stock-raising homestead act	1	3,036	34	3,002	−3,002
	7,251	12,635	9,489	10,397	−3,146
ineral character and water resources:					
General Land Office requests for information	1,465	2,513	2,997	981	+ 484
General Land Office field service reports	194	292	413	73	+ 121
General Land Office requests for information as to water resources, accompanied by field-service reports as to mineral character	67	107	153	21	+ 46
Indian Office requests for information	20	33	45	8	+ 12
	1,746	2,945	3,608	1,083	+ 663
Grand total	9,304	17,030	14,330	12,004	−2,700

MINERAL CLASSIFICATION.

COAL.

Regulations.—The only change that has been made in the regulations governing the classification and valuation of coal lands since their adoption in 1913 occurs in the last part of paragraph 2, which was revoked by a decision of Secretary Lane on February 16, 1915 (43 L. D., 520), the department holding that legally classification of coal land must be made by quarter quarter sections and surveyed lots and not by minor subdivisions of 2½ or 10 acres. Administration under these regulations has proved the soundness of the principles underlying them, and they furnish what is believed to be a just and reasonable standard for the disposition of public land underlain by coal of any quality or thickness.

Withdrawals and restorations.—The total area of coal-land withdrawals made during the year was 553,233 acres, approximately 84,000 acres less than last year. These withdrawals for the most part affect lands in Arizona not previously known to contain coal and land in Montana within the former Fort Peck Indian Reservation, which had been previously classified as coal land at the minimum price but which were withdrawn pending legislation and later in the year restored to entry at the former coal values. In New Mexico certain coal lands within the Navajo Indian Reservation that have been reconveyed by the Atchison, Topeka & Santa Fe Railway Co. to the United States Government were withdrawn pending examination and appraisal. Coal lands not hitherto known have been discovered in Arizona, New Mexico, Montana, and Washington and have been withdrawn by Executive order pending detailed examination. Like other recent years, the year has shown a substantial decrease in the area of land included in outstanding withdrawals of coal lands, because, although over 500,000 acres of land has been withdrawn during the year, a much larger area, more than 1,635,000 acres, has been restored as rapidly as field work and classifications have been completed, and the restorations thus effected during the year exceed the withdrawals by more than 1,000,000 acres.

Coal withdrawals and restorations, fiscal year 1916–17, in acres.

State.	Outstanding July 1, 1916.	New withdrawals, 1916–17.	Restorations, 1916–17.	Withdrawals outstanding June 30, 1917.
Arizona	118,718	67,197	43,970	141,945
California	17,643			17,643
Colorado	4,622,749		119,332	4,503,417
Idaho	338,452			338,452
Montana	11,131,717	464,780	683,928	10,912,569
Nevada	83,833			83,833
New Mexico	5,709,760	20,616	126,482	5,603,894
North Dakota	14,857,342		200,887	14,656,455
Oregon	4,361			4,361
Utah	5,426,730		100,474	5,326,256
Washington	847,255	640	20,702	827,193
Wyoming	2,777,394		339,671	2,437,723
	45,935,954	553,233	1,635,446	44,852,741

Classification.—Examinations made for coal-land classification have resulted in eliminating from withdrawal large areas of noncoal land in Montana, Wyoming, North Dakota, New Mexico, and Colorado and smaller areas in other States, thus continuing the policy of examining and eliminating from withdrawal as rapidly as possible areas of doubtful coal value. In Arizona certain lands within Indian reservations included in former coal withdrawals were restored in order to clear the records.

During the fiscal year more than 370,000 acres have been classified as coal land and more than 951,000 acres as noncoal land, a total classification of 1,321,989 acres. This is considerably less than the results of either of the preceding two years and far below those attained annually prior to that time. The decrease in classified areas within the last three years is due partly to the elimination of the larger noncoal areas from withdrawal and the consequent restriction of field examinations to a detailed study of known coal fields and partly to a decrease in allotments for coal-land examination on account of increased demands for the examination of other mineral deposits.

In the first of the following tables the classifications made during the year are summarized by States. In the same table the classifications are divided into two groups—reclassifications, which constitute a revision of previous classifications, and new classifications, which comprise the classification of withdrawn areas or areas not previously considered. The sum of these two groups is the total classification. The net increase or decrease in total areas classified in any State, as shown in the last two columns, is obtained directly from the other columns of the table.

Lands classified as coal and noncoal land, fiscal year 1916–17, in acres.

State.	Total classification.			Reclassification.		New classification.		Net increase or decrease in areas classified.	
	Coal.	Noncoal.	Total.	Previous noncoal, now coal.	Previous coal, now noncoal.	Coal.	Noncoal.	Coal.	Noncoal.
Colorado	71,501	105,110	176,611	....	57,599	71,501	47,511	+ 13,902	+105,110
Montana	73,994	231,742	305,736	52,939	12,807	21,055	218,935	+ 61,187	+178,803
New Mexico	14,109	181,561	195,670	1,962	67,226	12,147	114,335	− 53,117	+179,599
North Dakota	201,427	70	201,497	540	70	200,887	....	+201,357	− 470
Oregon	....	40	40	....	40	....	....	− 40	+ 40
Utah	8,938	72,758	81,696	....	30	8,938	72,728	+ 8,908	+ 72,758
Washington	320	20,228	20,548	....	....	320	20,228	+ 320	+ 20,228
Wyoming	160	340,031	340,191	....	520	160	339,511	− 360	+340,031
	370,449	951,540	1,321,989	55,441	138,292	315,008	813,248	+232,157	+896,099

Classifications of coal and noncoal land, June 30, 1917, in acres.

State.	Classification outstanding July 1, 1916.		Net result of classification, 1916–17.		Classification outstanding June 30, 1917.		
	Coal.	Noncoal.	Coal.	Noncoal.	Coal.	Noncoal.	Total.
Arizona	....	42,492	....	....	....	42,492	42,492
Arkansas	60,715	70,038	....	....	60,715	70,038	130,753
California	8,720	228,502	....	....	8,720	228,502	237,222
Colorado	3,348,564	9,250,638	+ 13,902	+105,110	3,362,466	9,355,748	12,718,214
Idaho	2,113	7,936,925	....	....	2,113	7,936,925	7,939,038
Montana	5,560,135	21,580,236	+ 61,187	+178,803	5,621,322	21,759,039	27,380,361
Nevada	5,880	2,428	....	....	5,880	2,428	8,308
New Mexico	728,214	3,554,103	− 53,117	+179,599	675,097	3,733,702	4,408,799
North Dakota	2,174,635	3,181,325	+201,357	− 470	2,375,992	3,180,855	5,556,847
Oregon	17,164	1,062,055	− 40	+ 40	17,124	1,062,095	1,079,219
South Dakota	250,123	6,956,108	....	....	250,123	6,956,108	7,206,231
Utah	1,066,663	3,234,333	+ 8,908	+ 72,758	1,075,571	3,307,091	4,382,662
Washington	148,940	1,562,308	− [a] 320	+ 20,228	148,620	1,582,536	1,731,156
Wyoming	7,623,325	14,941,289	− 360	+340,031	7,622,965	15,281,320	22,904,285
	20,995,191	73,602,780	231,517	+896,099	21,226,708	74,498,879	95,725,587

[a] 640 acres not priced, rewithdrawn; 320 acres coal priced; net, −320 acres.

Area and valuation of coal lands June 30, 1917.

State.	Appraised coal land July 1, 1916.	Coal land appraised 1916–17.		Net result of appraisals, 1916–17.	Total appraised coal land outstanding June 30, 1917.	Total valuation of appraised coal land outstanding June 30, 1917.	Average value per acre.
		Total coal land appraised.	Coal land reclassified as noncoal land and rewithdrawn.				
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*		
Arkansas	60,715	....	....	....	60,715	$1,473,762	$24.30
California	7,720	....	....	....	7,720	585,086	75.70
Colorado	2,863,585	71,501	57,599	+ 13,902	2,877,487	195,091,022	67.80
Idaho	2,113	....	....	....	2,113	51,824	24.50
Montana	5,445,592	73,994	12,807	+ 61,187	5,506,779	129,696,998	23.60
Nevada	5,880	....	....	....	5,880	117,600	20.00
New Mexico	710,262	14,109	67,226	– 53,117	657,145	15,682,664	23.90
North Dakota	2,174,635	201,427	70	+201,357	2,375,992	37,623,645	15.80
Oregon	6,915	....	40	– 40	6,875	121,651	17.70
South Dakota	250,123	....	....	....	250,123	2,758,587	11.00
Utah	1,048,542	8,938	30	+ 8,908	1,057,450	44,325,419	41.90
Washington	740	320	....	+ 320	1,060	22,400	21.10
Wyoming	7,448,456	160	520	– 360	7,448.096	385,436,687	51.70
	20,025,278	370,449	138,292	232,157	20,257,435	812,989,345	$40.90

Applications for classification as to coal.—During the present year the Survey received 44 applications for classification; 37 of these were requests for classification as coal land and 7 as noncoal land. There were also pending at the beginning of the year 12 applications for coal classification and 3 for noncoal. Of the total 59 received and pending cases, 15 were approved—12 as coal and 3 as noncoal—and 13 disapproved—9 as coal and 4 as noncoal. At the end of the year there were pending 31 requests for classification, of which 28 were for coal and 3 for noncoal.

OIL.

Withdrawals and restorations.—The examination and withdrawal of the public lands with reference to their prospective value for deposits of petroleum and natural gas was continued during the year in California, Wyoming, and Montana. The examinations were made for the purpose of reducing the outstanding oil withdrawals in so far as the data indicated that the withdrawn lands were not valuable for oil and of adding new areas to the oil reserves wherever the data indicated the presence of oil. These examinations resulted in eliminating from withdrawal 176,311 acres of nonoil land and added to the withdrawals 903,791 acres of prospective oil land, a net increase of 727,480 acres for the year.

In California more than 104,000 acres in the Salinas Valley, principally in Monterey County but in part in San Luis Obispo County, was restored to entry, field examination by the Survey having shown these lands to be barren of oil. Field work in the Salinas Valley also resulted in the restoration of a little more than 12,000 acres of land in Monterey County withdrawn a year ago because it was believed to be favorable for oil accumulation but later found to be almost entirely private land. A restoration of 4,695 acres in Orange and Los Angeles counties was made as a result of the decision rendered by the Supreme Court in the Burke case (224 U. S., 669).

In Wyoming an area of a little less than 38,000 acres in the Big Horn Basin was restored to entry during the year, and about 904,000 acres in Wyoming were included in withdrawals. Approximately 10,000 acres of land in the Big Horn Basin has been withdrawn on the basis of detailed field examination and office work. Approximately 27,000 acres were withdrawn in the Hanna Basin, in southern Wyoming, and the remainder of the withdrawn area of about 133,000 acres lies in the Big Muddy and Lost Soldier fields and in the vicinity of Powder River station.

The discovery of oil in the fall of 1915 near the Wyoming-Montana line made it advisable to withdraw certain favorable areas in the northern part of the Big Horn Basin previously known to the Survey but not included in an oil withdrawal. Part of the area so withdrawn was examined, and the examination resulted in restoring more than 37,600 acres of withdrawn land in this part of the State.

The keen interest manifested in the possible occurrence of oil in Montana about a year ago, after the discovery of oil in Elk Basin, near the Montana-Wyoming State line, caused the Survey to recommend the withdrawal of all areas of favorable structure known in this part of the State, in continuance of the departmental policy of holding prospective oil lands until appropriate legislation for their disposition can be enacted. Some of the withdrawn land in this part of Montana was examined by the Survey and found to be barren of oil, and more than 29,900 acres in southern Montana was restored to entry. Other areas in the State, the largest of which was that of the Malta or Bowdoin dome, in the upper Milk River valley, were withdrawn.

Oil withdrawals and restorations, fiscal year 1916–17, in acres.

	Withdrawals outstanding July 1, 1916.	New withdrawals, 1916–17.	Restorations, 1916–17.	Withdrawals outstanding June 30, 1917.
	Acres.	*Acres.*	*Acres.*	*Acres.*
Arizona	230,400			230,400
California	1,365,947		108,718	1,257,229
Colorado	87,474			87,474
Louisiana	467,030			467,030
Montana	641,622	734,432	29,949	1,346,105
North Dakota	84,874			84,894
Utah	1,952,326			1,952,326
Wyoming	791,467	169,359	37,644	923,182
	5,621,160	903,791	176,311	6,348,640

Oil-shale withdrawals.—Of special interest during the year was the creation of two naval oil-shale reserves, one of 45,440 acres in Colorado and one of 86,584 acres in Utah. Lands included within these reserves are not subject to agricultural or mineral entry and in that respect differ from the classified oil-shale land.

Classification.—Most of the lands examined and included in oil withdrawals have not definitely been classified as oil lands, and no classification of oil lands outside of Indian reservations was made during the fiscal year. The lands on which oil is known or believed to be present in commercial quantities have been included in oil withdrawals pending further detailed examinations, in order to determine the mineral character of these lands and to hold the lands until legislation providing for their disposition is enacted. Lands included in oil withdrawals may therefore be considered tentatively as oil lands, although they have not, with the exception of some of the land in California, been so classified. In addition to the classifications that are reported as withdrawals and restorations in the preceding table, a direct classification as oil land of 42,097 acres in the Blackfeet Indian Reservation, Mont., has been made. Examinations of lands in such reservations are frequently made for the information of the Office of Indian Affairs in its administration of Indian lands. Mineral classification of certain oil lands within the Northern Pacific land grant have been reported to the Commissioner of the General Land Office, but these lands are a part of the outstanding oil reserves and are included in the table given above.

The classification of oil-shale land in Utah was continued in 1916, and large areas have been added to the classified mineral lands. Field examination by the Survey during the four seasons of 1913–1916 has shown that the potentiality of the oil shale of this region as a source of petroleum is enormous. There is also locked up in these shales a vast amount of nitrogen which can be recovered as a by-product in the refining of the shale and used in the manufacture of fertilizers, explosives, etc.

Classification of oil-shale land, fiscal year 1916–17, in acres.

State.	Outstanding July 1, 1916, (mineral).	Classified during fiscal year.		Outstanding June 30, 1917.	
		Mineral.	Nonmineral.	Mineral.	Nonmineral.
Colorado	893,418	2,600	....	896,018	....
Utah	112,950	2,527,709	[a] 4,744	2,635,915	4,744
Wyoming	460,103	....	....	460,103	....
	1,466,471	2,530,309	4,744	3,992,036	4,744

[a] Reclassification of area previously classified as mineral land.

Applications for classification.—During the year the Survey received 27 applications for classification of withdrawn oil lands as nonoil land. At the beginning of the year there were also pending three applications for classification as to oil, making a total for the year of 30 cases. Six of these were approved and the lands were restored to entry; 18 were disapproved for the reason that the lands were included in an outstanding oil reserve and the data on file indicate that the lands are valuable for deposits of oil, or because no detailed information is available to the Survey to prove that they are nonoil land, and the data submitted by the applicants were rejected because the evidence submitted did not show that the land is nonoil land and could not be used as a basis for nonoil classification. At the end of the year there remained pending six applications.

PHOSPHATE.

Regulations.—There has been no change in the procedure affecting the classification of phosphate lands. Under the regulations defining phosphate lands, adopted by the Survey in 1912 to guide its recommendations for withdrawal and restoration, lands underlain by deposits containing less than 30 per cent of tricalcium phosphate are considered nonmineral lands. Phosphate beds that are from 1 foot to 6 feet or more in thickness and contain 70 per cent or more of tricalcium phosphate are held to depths ranging from zero along the outcrop to the maximum of 5,000 feet in direct ratio to the variation of the thickness of the bed from 1 to 6 feet. For beds containing less than 70 per cent of tricalcium phosphate the depth limit varies from zero to the depth of a 70 per cent bed of any given thickness in direct ratio to the variation in tricalcium phosphate content from 30 to 70 per cent.

Withdrawals and restorations.—During the year, as in previous years, field examination has been made to obtain information regarding the phosphate character of public lands in order that the nonphosphate areas might be eliminated from the phosphate reserves and newly discovered phosphate areas might be included. Phosphate work was carried on in Idaho, Montana, Utah, and Wyoming, but the results of these investigations were not assembled by the end of the year, and no action has been taken. As a result of the work new withdrawals and restorations will be made as soon as the field work is compiled and the data made available. No withdrawals have been made during the year, and only one restoration, including 80 acres in Florida, has been approved.

Phosphate withdrawals and restorations, fiscal year 1916–17, in acres.

State.	Withdrawals outstanding July 1, 1916.	Restorations, 1916–17.	Withdrawals outstanding June 30, 1917.
Florida	119,817	80	119,737
Idaho	966,377	....	966,377
Montana	119,227	....	119,227
Utah	302,465	....	302,465
Wyoming	998,592	....	998,592
	2,506,478	80	2,506,398

Classifications.—Indian lands, such as those included in the Fort Hall Indian Reservation, Idaho, and in the Shoshone or Wind River Indian Reservation, Wyo., are not public lands, and therefore such lands can not be withdrawn. Examinations of lands in such reservations are frequently made for the information of the Office of Indian Affairs in its administration of them. If these examinations are made for the purpose of determining whether or not the lands contain phosphate, the results are transmitted not as withdrawals or restorations but as classifications either as phosphate or nonphosphate lands. Mineral classifications of certain phosphate lands within the Northern Pacific land grant have been reported to the Commissioner of the General Land Office, but these lands are a part of the outstanding phosphate reserves and are included in the table given above.

In addition, therefore, to the classifications that are reported as withdrawals and restorations in the preceding table, direct classifications of lands in the Fort Hall Indian Reservation, Idaho, and the Wind River Indian Reservation, Wyo., have been made as indicated in the following table:

Phosphate classifications of Indian lands outstanding June 30, 1917, in acres.

State.	Phosphate land.	Nonphosphate land.
Idaho	4,080	17,440
Wyoming	20,576	85,515
	24,656	102,955

Applications for classification.—During the fiscal year the Survey received five applications for classification of withdrawn lands as nonphosphate land. Two of these were approved and the lands restored to entry; two were disapproved because the data on file indicate that the lands are valuable for deposits of phosphate or because no detailed information is available to the Survey, and the evidence submitted by the applicants was not sufficiently definite to be used as a basis for a nonphosphate classification; and one remained pending at the end of the year.

POTASH.

Field work in search of commercial deposits of potash was continued by the geologic branch of the Survey during the fiscal year, but no new areas were found on the public lands. No new areas were withdrawn, and no changes were made in the two existing potash reserves in California, Searles Lake, and Panamint Valley, aggregating 91,207 acres, or in the potash reserve of 39,422 acres at Columbus Marsh, Nev.

METALLIFEROUS LANDS.

The act of February 26, 1895 (28 Stat., 683), made provision for classifying the lands within the Northern Pacific Railroad grant in certain land districts in Montana and Idaho with respect to their mineral or nonmineral character, the work to be done by commissioners appointed for the purpose. The classifications made in many areas were unsatisfactory, and a reclassification was provided for in the sundry civil act of June 25, 1910 (36 Stat., 739). At the request of the General Land Office the work is being done by the Geological Survey. Field examination of these lands was first undertaken by the Survey during the field season of 1910. The work has been continued during subsequent years, and field examination of all lands thus far listed to the Survey for examination and report has been completed and the classification furnished to the Commissioner of the General Land Office.

Lands in Northern Pacific Railroad grant in Idaho and Montana classified, fiscal years 1911–1917, in acres.

State.	Classification.	1911	1912	1913	1914	1915	1916	1917	Total.
Idaho	Mineral	45,645	19,444	1,000	....	....	....	......	65,789
	Nonmineral	90,712	53,055	1,200	....	....	478	......	145,445
		136,357	72,199	2,200	....	....	478	......	211,234
Montana	Mineral	130,386	1,134	19,800	480	6,629	....	......	158,429
	Nonmineral	21,802	83,981	65,570	7,696	7,911	2,229	160	189,349
		152,188	85,115	85,370	8,176	14,540	2,229	160	347,778
Idaho and Montana	Mineral	176,031	20,278	20,800	480	6,629	....	......	224,218
	Nonmineral	112,514	137,036	66,770	7,696	7,911	2,707	160	334,794
		288,545	157,314	87,570	8,176	14,540	2,707	160	559,012

In addition to the above work a supplemental report was furnished to the Secretary of the Interior covering certain manganese areas examined by the Survey in 1915. The entire area included in the Gila Indian Reservation, Ariz., was examined as to the mineral character of the lands in the reservation, but a report has not yet been furnished to the Commissioner of Indian Affairs, as the chemical work on the mineral specimens collected in the field has not been completed.

Withdrawals.—No new areas were withdrawn and no change was made in the mineral-land withdrawal of 8,507 acres in Arizona.

HYDROGRAPHIC CLASSIFICATION.

WATER POWER.

Withdrawals and restorations.—The classification of the public lands with relation to their value in connection with water-power development was continued during the year, the withdrawals being made under the authority conferred by the two acts of June 25, 1910 (36 Stat., 847; 36 Stat., 855, 858), and the act of August 24, 1912 (37 Stat., 497). On July 1, 1916, the area included in outstanding withdrawals was 2,352,652 acres. During the year 156,353 acres additional were withdrawn, and 79,908 acres previously included in power-site reserves were restored to the public domain. On June 30, 1917, the total area withdrawn in connection with water power was 2,429,097.

Power sites withdrawn, restored to entry, and outstanding, fiscal year 1916–17, in acres.

State.	Withdrawals outstanding July 1, 1916.	New withdrawals, 1916–17.	Restorations, 1916–17.	Withdrawals outstanding June 30, 1917.
Alabama	120			120
Alaska	69,300			69,300
Arkansas	22,354			22,354
Arizona	335,791	27,173	62,640	300,324
California	256,090	8,323	407	264,006
Colorado	273,670	3,124	290	276,504
Idaho	260,745	2,987	1,238	262,494
Michigan	1,240			1,240
Minnesota	12,309			12,309
Montana	171,891	536	8,130	164,297
Nevada	26,153	1,208		27,361
Nebraska	761			761
New Mexico	13,577	49,705	680	62,602
Oregon	261,676	56,406	764	317,318
Utah	451,217	760	4,553	447,424
Washington	108,593	5,427	240	113,780
Wyoming	87,165	704	966	86,903
	2,352,652	156,353	79,908	2,429,097

Water-power designations.—The act of June 20, 1910 (36 Stat., 557), enabling Arizona and New Mexico to enter the Union as States, reserved to the United States all lands actually or prospectively valuable for power sites so far as ascertained and designated by the Secretary of the Interior within five years after the proclamation of the President declaring admission of the new States. The five-year period terminated February 14, 1917, for Arizona and January 6, 1917, for New Mexico. No designations were made prior to the current fiscal year, though investigations and surveys preliminary to designation had been in progress for several field seasons. Prior to the expiration of the five-year period referred to, however, designations were made covering all lands in the two States believed to be actually or prospectively valuable for power sites, the areas being 764,438 acres in Arizona and 201,000 acres in New Mexico. Such of these lands as were not otherwise withdrawn were also included in power-site reserves under appropriate acts of Congress.

The act of June 9, 1916 (39 Stat., 218), revesting in the United States title to lands held by the Oregon & California Railroad Co., provides for the classification as "power-site lands" of the revested lands found to be chiefly valuable for water-power sites. During the fiscal year 31,765 acres of power-site lands in Oregon were classified under this act, and such of them as were not otherwise withdrawn were included in power-site reserves under appropriate acts of Congress.

Applications for reclassification.—At the beginning of the fiscal year 12 applications for the reclassification of lands included in power-site reserves were awaiting action, and during the year 78 were received, making a total of 90 cases. Action was taken on 72 cases, leaving 18 pending at the end of the year.

Right of way applications.—Departmental regulations of January 6, 1913, under the act of Congress approved March 4, 1911 (36 Stat., 1235, 1253), and of March 1, 1913, under the act of Congress approved February 15, 1901 (31 Stat., 790), charge the Geological Survey with important administrative duties in connection with applications for rights of way over the public lands for purposes related to the development of water power. Such applications, when received in proper form at the General Land Office, are forwarded to the Survey for consideration of such matters as relative priority of applications, incompatibility of works, relative beneficial utilization of resources, and the engineering and economic features involved in the applications and permits. If the approval of an application is found to be compatible with the public interest, a draft of agreement is prepared, and a report is made to the Secretary of the Interior on the circumstances in the case. This agreement, after execution by the applicant and issuance of the permit by the Secretary of the Interior, defines the conditions under which the power is to be developed, the tenure of the site, and the provisions for the protection of the public interest as regards distribution of output, rates, and service.

During the year favorable reports were rendered on 14 applications for permit under the act of February 15, 1901, involving the development of 4,223 continuous horsepower and the construction of 194 miles of transmission lines. Favorable reports were also rendered on five applications for grants under the act of March 4, 1911, for right of way for 49 miles of transmission line.

In pursuance of the Secretary's instructions of August 24, 1916, 26 permittees under the act of February 15, 1901, and grantees under the act of March 4, 1911, were called on for reports of their operations during the calendar year 1916. The reports received show that public lands under permit or grant from the Secretary of the Interior were used during the year for the generation or transmission of about 1,200,000,000 kilowatt-hours of electric energy, the equivalent of 156,000 continuous horsepower.

In addition to applications for rights of way for hydroelectric development, a large number of applications of other types are referred to the Geological Survey for consideration and report. These embrace applications for rights of way for railroads, under the acts of March 3, 1875 (18 Stat., 482), and March 2, 1899 (30 Stat., 990), affecting public lands and Indian reservations, respectively, on which report is made as to whether or not the construction of the railroad will interfere with power or irrigation development on streams in the vicinity of the right of way; applications for rights of way for irrigation uses, under the act of March 3, 1891 (26 Stat., 1095), on which report is made as to interference with power development, the feasibility of the project, and other features; applications for rights of way across national forests for mining, milling, and municipal purposes, under the act of February 1, 1905 (33 Stat., 628); and a variety of miscellaneous applications for domestic, municipal, mining, and railroad water supply.

Applications for rights of way, fiscal year 1916–17.

Class.	Pending July 1, 1916.	Received 1916–17.	Acted on 1916–17.	Pending June 30, 1917.
Railroad: Acts of Congress approved Mar. 3, 1875 (18 Stat., 482), May 13, 1898 (30 Stat., 409), Mar. 2, 1899 (30 Stat., 990), etc.	28	69	77	20
Irrigation: Acts of Congress approved Mar. 3, 1891 (26 Stat., 1095), and May 11, 1898 (30 Stat., 404), etc	24	119	127	16
Power: Acts of Congress approved Feb. 15, 1901 (31 Stat., 790), Mar. 4, 1911 (36 Stat., 1235, 1253), etc.	33	25	29	29
Miscellaneous: Acts of Congress approved Jan. 21, 1895 (28 Stat., 635), May 21, 1896 (29 Stat., 127), Jan. 13, 1897 (29 Stat., 404), May 11, 1898 (30 Stat., 404), Feb. 15, 1901 (31 Stat., 790), Feb. 1, 1905 (33 Stat., 628), Mar. 4, 1911 (36 Stat., 1235, 1253), etc.	13	108	114	7
Total number of applications for original consideration	98	321	347	72
Additional applications for reconsideration	36	22	37	21

IRRIGATION.

Reservoir withdrawals.—A number of reservoir sites, valuable principally for the storage of water for irrigation, have been examined by the Geological Survey, and, on its recommendation, the lands they include have been withdrawn from entry. There was no change in the status of such withdrawals during the fiscal year. The following table shows the area of such withdrawals outstanding:

Reservoir sites outstanding June 30, 1917.

	Acres.
Arizona	23, 040
Montana	9, 080
North Dakota	1, 569
Oregon	10, 619
Washington	35 943
	80, 251

Carey Act segregations.—During the year four proposed segregation lists under the Carey Act were received for report as to available water supply, general feasibility of plan of reclamation, and mineral character of the lands. One such list was pending report on July 1, 1916. Reports on all these lists had been submitted before the end of the year, and supplemental reports on five other lists were also furnished.

Irrigation projects.—The Geological Survey, by instructions of the Secretary of the Interior dated March 15, 1913, furnishes to the Commissioner of the General Land Office information relative to the available water supply and the feasibility of irrigation projects whose water rights or shares are presented as evidence of compliance with the requirements of the desert-land act. During the year 87 such cases were received, and 51 were carried over from the preceding year. Of these 138 cases 72 were reported on and 66 were pending June 30, 1917. Supplemental reports were rendered on 10 cases.

ENLARGED HOMESTEADS.

Classification of lands under the enlarged-homestead acts of February 19, 1909 (35 Stat., 639), June 17, 1910 (36 Stat., 531), June 13, 1912 (37 Stat., 132), March 3, 1915 (38 Stat., 953), and March 4, 1915 (38 Stat., 1162), was continued during the year. These acts are now applicable to 14 States. As a result of the investigations of surface and underground water conditions, designations during the fiscal year have added a large area of land to that previously classified.

Enlarged-homestead designations, fiscal year 1916–17, in acres.

State.	Outstanding July 1, 1916.	Designations 1916–17.	Cancellations 1916–17.	Outstanding June 30, 1917.
Arizona	25,125,355	213,692	....	25,339,047
California	4,875,197	2,337,251	....	7,212,448
Colorado	26,026,922	947,321	13,750	26,960,493
Idaho:				
Sections 1–5 only	9,754,609	290,901	2,833	10,042,677
Section 6	124,828	2,873	2,792	124,909
	9,879,437	293,774	5,625	10,167,586
Kansas	372,684	95,455	....	468,139
Montana	48,502,807	1,018,116	678	49,520,245
Nevada	46,305,197	....	3,445	46,301,752
New Mexico	25,468,032	3,299,319	18,895	28,748,456
North Dakota	9,560,710	1,934,493	....	11,495,203
Oregon	17,874,712	122,082	....	17,996,794
South Dakota	14,426,192	1,059,797	....	15,485,989
Utah:				
Sections 1–5 only	7,150,736	374,376	38,790	7,486,322
Section 6	1,274,124	68,173	8,928	1,333,369
	8,424,860	442,549	47,718	8,819,691
Washington	5,196,302	250,842	....	5,447,144
Wyoming	20,574,410	1,119,160	22,696	21,670,874
	262,612,817	13,138,851	112,807	275,638,861

The general provisions of the acts, which apply in all 14 States, permit the entry by one person of 320 acres of "nonmineral, nonirrigable, unreserved, and unappropriated surveyed public lands which do not contain merchantable timber." As a prerequisite to the allowance of such entry, the land must have been designated by the Secretary of the Interior as not being, in his opinion, "susceptible of successful irrigation at a reasonable cost from any known source of water supply." Under the provisions of sections 6 of the acts of February 19, 1909, and June 17, 1910, applicable in Utah and Idaho only, the Secretary may further designate lands which do not have upon them "such a sufficient supply of water suitable for domestic purposes as would make continuous residence upon the lands possible," and entrymen upon such lands are relieved of the necessity of residence. By the act of March 3, 1915 (38 Stat., 956), the enlarged-homestead act was amended so as to permit, under certain conditions, an additional entry, though final proof had already been submitted on the original entry.

A seventh section was added to the enlarged-homestead act of February 19, 1909, by the act of July 3, 1916 (39 Stat., 344), which permits an additional entry for land not contiguous to that originally entered after submission of final proof on the original entry. Under this section residence is required on the additional entry in conformity with the homestead laws except where the additional entry lies within 20 miles of the original homestead and the prospective entryman still owns and resides upon his original homestead, in which case no residence upon the additional entry will be required. The act applied to all States affected by the general provisions of the enlarged-homestead act except Idaho, but by the act of September 5, 1916 (39 Stat., 724), the act of June 17, 1910, extending the provisions of the enlarged-homestead act to Idaho, was amended by adding thereto a section 7 identical with that added to the 1909 act on July 3, 1916.

Noncontiguous entries under section 6 of the enlarged-homestead act are not permitted under these acts.

The enlarged-homestead acts of February 19, 1909, and June 17, 1910, were further amended by the act of February 20, 1917 (39 Stat., 925), which provides that a homesteader who has received patent to an area of less than a quarter of a section may make entry and obtain title under these two homestead acts, "for such an area of public land as will, when one-half of such area is added to the area of the lands to which he has already obtained title, not exceed one quarter section." Under this act additional entries can be allowed in the cases mentioned without the necessity of the land in the original homestead being designated as subject to entry under the enlarged-homestead act.

Under the act of February 20, 1917 (Public 340), any person who prior to the passage of the act entered under the homestead laws lands included in a ceded Indian reservation and paid therefor a price equivalent to or greater than $4 an acre is entitled to the benefits of the homestead law as if such entry had not been made. The privileges of this act extend only to persons who have submitted final proof on the land previously entered and paid the entire purchase price therefor. Any such person may enter land under the enlarged-homestead act where the proposed additional entry only has been designated as subject to such entry and without the necessity of the ceded Indian lands in the original homestead being designated.

Designations under the enlarged-homestead acts are made either in large, compact areas, as a result of field investigations covering rather large districts, or in small units, as a result of investigations made at the request of prospective entrymen. These requests are referred to as enlarged-homestead petitions. The passage of the act of March 4, 1915 (38 Stat., 1162), which provides that a preference right of entry in the event of designation can be procured by filing an application at the local land office of the district in which the lands are situated, has led to a very large increase in the number of applications received.

Action on petitions under the enlarged-homestead acts, fiscal year 1916–17.

	Pending July 1, 1916.	Received 1916–17.	Action taken, 1916–17.					Pending June 30, 1917.	Cases reconsidered.
			All designated.	Part designated.	Refused.	Recalled.	Total.		
Arizona	112	102	57	10	46	1	114	100	1
California	619	774	945	9	25	27	1,006	387	18
Colorado	997	1,358	984	26	85	37	1,132	1,223	42
Idaho	1,064	656	302	11	20	129	462	1,258	39
Kansas	13	430	401	3	3	1	408	35	17
Montana	1,055	1,664	1,392	79	331	39	1,841	878	252
Nevada	43	14	....	....	2	....	2	55	....
New Mexico	948	1,104	992	18	151	61	1,222	830	17
North Dakota	78	417	261	12	22	9	304	191	15
Oregon	156	397	32	4	....	17	53	500	3
South Dakota	445	720	657	36	49	8	750	415	29
Utah	845	338	326	12	149	48	535	648	15
Washington	114	230	115	2	7	....	124	220	4
Wyoming	549	835	759	22	123	11	915	469	32
	7,038	9,039	7,223	244	1,013	388	8,868	7,209	484

A set of maps of the States affected, showing areas designated under the enlarged-homestead acts and the status of designations on June 30, 1917, has been printed.

STOCK-RAISING HOMESTEADS.

The stock-raising homestead law, approved December 29, 1916 (39 Stat., 862), authorizes the Secretary of the Interior to designate unreserved public lands in any of the public-land States, but not in Alaska, as "stock-raising lands."

The lands to be designated are those whose surface is chiefly valuable for grazing and raising forage crops, which do not contain merchantable timber, are not susceptible of irrigation from any known source of water supply, and are of such character that 640 acres is reasonably required to support a family. The classification of these lands will be made by the Survey on the basis of data now available or to be collected by field parties.

Before June 30 nearly 62,000 applications to enter lands under this act were received in the local land offices, involving about 24,000,000 acres. These applications were distributed by States as follows:

Applications under the stock-raising homestead law, fiscal year 1916–17.

	Number of applications.	Area in acres.		Number of applications.	Area in acres.
Arizona	1,321	559,084.91	North Dakota	700	211,553.33
California	2,567	1,042,238.04	Oklahoma	52	12,528.01
Colorado	5,767	2,205,519.37	Oregon	4,522	1,696,282.88
Idaho	4,398	1,803,447.77	South Dakota	4,182	1,409,471.54
Kansas	80	19,971.89	Utah	1,750	921,631.69
Montana	11,885	3,793,860.66	Washington	830	274,553.61
Nebraska	209	27,200.77	Wyoming	10,106	4,176,367.67
Nevada	150	78,185.47			
New Mexico	13,390	5,730,558.55		61,909	23,962,456.16

Only a small proportion of these cases were transmitted to the Survey during the year.

No appropriation was made for the administration of this law until the last month of the fiscal year, and it was therefore not possible to classify any lands under the act, as field examination will be required in a majority of the cases before classification can be made. Plans were made, however, before the funds became available, for the employment, organization, and equipping of a field force, and considerable work was also done in collecting such information as could be obtained by correspondence with the applicants.

PUBLIC WATER RESERVES.

The litigation before the department over the validity of the withdrawals for public water reserves, which has been prosecuted in the past more or less vigorously, presumably in the interest of large stock owners in various arid parts of the West, has been effectively terminated by section 10 of the stock-raising homestead act of December 29, 1916 (39 Stat., 862). Under this section the creation of public water reserves by Executive order under the act of June 25, 1910 (36 Stat., 847), is expressly recognized as being within the authority then granted to the President.

Immediately after the enactment of the stock-raising homestead law the scope of the investigations undertaken to locate lands principally valuable for stock-watering places, which control grazing privileges on public lands, was greatly enlarged. One of the first steps taken was the making of arrangements with the General Land Office whereby a large number of requests for field examinations have been made in cases covered by the cooperative agreement with that bureau. In addition to data contained in reports submitted in response to these requests, it is expected that the investigations of stock-raising homesteads being made by the Survey will yield a large amount of data during the next year, on the basis of which, it is probable, a large number of water reserves will be created.

At the present time over 900 watering places consisting of springs, creeks, and other sources of water supply have been considered and approximately 850 of these are now included in public water reserves. During the year 11,934 acres have been withdrawn and 3,498 acres have been restored, making a net increase of 8,436 acres in the area withdrawn.

Public water reserves withdrawn from entry and restored to entry, fiscal year 1916–17, in acres.

State.	Withdrawals outstanding July 1, 1916.	New withdrawals, 1916–17.	Restorations, 1916–17.	Withdrawals outstanding June 30, 1917.
Arizona	9,922	2,516	....	12,438
California	49,846	2,788	160	52,474
Colorado	480	....	....	480
Idaho	6,170	1,040	....	7,210
Montana	1,040	2,264	....	3,304
Nevada	4,336	....	....	4,336
New Mexico	1,440	846	....	2,286
Oregon	2,500	160	178	2,482
Utah	33,987	....	160	33,827
Washington	....	40	....	40
Wyoming	83,551	2,280	3,000	82,831
	193,272	11,934	3,498	201,708

PUBLICATION BRANCH.

DIVISION OF BOOK PUBLICATION.

SECTION OF TEXTS.

During the year 68,411 pages of manuscript were edited and prepared for printing, and proof sheets for 23,162 final printed pages were read and corrected, this work involving the handling of 5,869 galley proofs and 29,273 page proofs. Indexes were prepared for 73 publications, covering 15,139 pages. A third edition of the pamphlet "Suggestions to authors," by G. M. Wood, editor, and a pamphlet entitled "Extracts from the Style Book of the Government Printing Office," compiled by Mr. Wood, were issued during the year.

At the end of the year eight persons were employed in this section. The water-resources branch has continued to render special assistance in copy preparing and proof reading.

SECTION OF ILLUSTRATIONS.

The number of illustrations prepared was 3,563, comprising 190 maps, 728 photographs prepared for reproduction, 834 diagrams and sections, 1,580 paleontologic drawings and photographs, and 231 miscellaneous illustrations. The illustrations sent to the printer were reproduced by chromolithography, photolithography, the four-color process, halftone engraving, zinc etching, wax engraving, and cuts already engraved, a total of 1,515 subjects. Proofs to the number of 2,087 were examined. Electrotypes of 57 cuts were furnished to outside applicants. At the end of the year material for illustrating 38 reports was in preparation.

DIVISION OF DISTRIBUTION.

The section of distribution, which had previously been a part of the division of book publication, was designated the division of distribution September 1, 1916, with R. C. Shelsé as chief.

Editions of 203 new books and pamphlets, 46 reprinted books and pamphlets, 5 new geologic folios, 14 new geologic maps, 86 new or revised topographic maps, 140 reprinted topographic maps, 9 new photolithographed maps, and 4 reprinted photolithographed maps, making a total of 507 publications, were received during the year. Many other special pamphlets and forms prepared for administrative use were received and distributed.

The total units of all publications received numbered 710,749 books and pamphlets, 21,753 folios, 1,732 geologic maps, 781,644 topographic maps, a grand total of 1,515,878.

The division distributed 607,101 books, 21,235 folios, and 676,526 maps, a total of 1,304,862, of which 29 books, 17,551 folios, and 475,036 maps were sold. The total amount received and deposited in the Treasury as the result of sales of publications was $35,388.79. The sales of topographic and geologic maps amounted to $33,952.84, of topographic and geologic folios to $1,383.30, and of books to $52.65. The division received and answered 104,070 letters.

DIVISION OF MAP EDITING.

SECTION OF GEOLOGIC MAPS.

The publication of the maps and illustrations of folios continued under the direction of George W. Stose, geologist, in charge of this section.

The five folios completed this year are numbered 202 to 206. Of these the Detroit folio covers five quadrangles (Wayne, Detroit, Grosse Pointe, Romulus, and Wyandotte, Mich.), in which there are several large cities with institutions of higher education and many important industries based on natural resources, so that the folio will be of much interest to the community. Three other folios cover two quadrangles each (Eureka Springs and Harrison, Ark.; Leavenworth and Smithville, Mo.-Kans.; Colorado Springs and Manitou, Colo.). In the Colorado Springs folio are described and illustrated Colorado Springs, Manitou, the Garden of the Gods, Monument Park, and Pikes Peak, and this folio will therefore be in large demand by travelers as well as by local residents.

At the end of the fiscal year the maps and illustrations of the Deming (N. Mex.), Colchester-Macomb (Ill.), and Newell (S. Dak.) folios were completed, and the texts were well advanced. The maps of the Herman-Morris (Minn.) folio were ready to be printed and the illustrations were completed. The maps of the Elkton-Wilmington (Md.-Del.-Pa.-N. J.), Black Hills (S. Dak.), and Syracuse-Lakin (Kans.) folios were partly engraved. The Black Hills folio covers four quadrangles, and part of the same area is also represented on a larger scale in greater detail. Maps of several other folios and reports were drawn and partly prepared for publication in this section during the year. In addition to the work on folios the maps, sections, and other illustrations for fifty Survey reports were critically reviewed by the geologist in charge of the section.

SECTION OF TOPOGRAPHIC MAPS.

At the beginning of the year 149 topographic maps were on hand for publication, and the accessions during the year were 78, making a total of 227 maps. Of these, 2 (Lynn, Ind.-Ohio, and Seiad, Cal.) were withdrawn for additional field work, 2 (Capon Bridge and Berryville, W. Va.) were printed for office use only, 93 have been published, 111 are in process of engraving and printing, and 19 (of which 12 have been edited) have not yet been transmitted to the engraving division. Of the 95 maps published (see list, pp. 31–32) 86 are new engraved maps and 9 are photolithographs. The following statement shows the comparative status of map editing and map publication on June 30 for the last seven years:

Progress of map publication for seven years ended June 30, 1917.

	1911	1912	1913	1914	1915	1916	1917
Published during the year	86	114	101	102	107	153	95
In process of engraving and printing	56	65	89	69	87	97	111
In hand for engraving	95	102	105	114	91	52	[a] 19

[a] Preparation of manuscripts from 1916 surveys delayed by war work.

The manuscripts edited during the year comprise 108 maps prepared for engraving, 3 maps for photolithography, 196 maps or sheets for the illustration of 30 Survey reports, and corrections for 227 maps about to be reprinted. The proof read comprises 84 new topographic maps, 5 maps engraved and printed under contract, and corrections to 104 old maps. The index maps for 9 circulars of the series 9–323 were revised and reprinted, 20 of the State circulars were revised and reprinted, as was also the wall index map of the United States.

The decisions of the United States Geographic Board have been grouped by States and counties, and a list in this form, without the descriptions, has been prepared for publication. A revision of Bulletin 299, Geographic dictionary of Alaska, has also been in progress and is far advanced. Six men were continuously employed in the section.

DIVISION OF ENGRAVING AND PRINTING.

TOPOGRAPHIC MAPS AND GEOLOGIC FOLIOS.

During the fiscal year 86 topographic maps were engraved and printed; other editions were 7 photolithographed State maps and 2 photolithographed topographic maps of Willamette Valley, making a total of 95 new maps.

Corrections were engraved on the plates of 211 maps and 17 were in hand for correction. Of the 211 corrected maps, 119 were for reprint editions, 59 were in hand for printing, and 33 were corrected for other purposes. Four photolithographic State maps were corrected and reprinted and reprint editions of 21 topographic maps in hand at the beginning of the year were completed.

Of the new and reprinted maps, 239 different editions, amounting to 781,644 copies, were printed and delivered to the map room. This is a decrease of 25 editions and 146,209 copies from the preceding year.

Five new geologic folios were published, of which three were double folios and one (Detroit, Mich.) contained five sets of geologic maps. State editions of two folios, an octavo edition of one folio, and a field edition of one folio were issued during the year. Editions and partial editions amounting to 21,753 copies were printed and delivered, an increase of 913 copies over the number printed in the preceding year; 1,732 extra areal-geology sheets of the different folios were also printed.

OTHER GOVERNMENT MAP PRINTING.

For the Government Printing Office the following items were printed and delivered: Illustrations for the annual reports of the governor of Alaska, the governor of Hawaii, the Commissioner General of Immigration, the Commissioner of Indian Affairs, and the Superintendent of the Coast and Geodetic Survey, Department of Commerce Special Publication 40, Department of Agriculture Bulletin 460; report of the Federal Trade Commission on the price of gasoline; soil surveys of Barbour County Ala.; Chickasaw County, Miss.; Dekalb County, Mo.; Dunklin County, Mo.; Franklin County, Fla.; Hamilton County, Ohio; Hampton County, S. C.; Latah County, Idaho; New Castle County, Del.; Richarson County, Nebr.; Schoharie County, N. Y.; Smith County, Tex.; Washington County, Nebr.; and Wells County, Ind.; Bureau of Mines Bulletin 107 and Technical Paper 155, American Ephemeris and Nautical Almanac, 1917, 1918, and 1920; Report on fertilizer industry (64th Cong., 1st sess., S. Doc. 872); Report on development of East Potomac Park (64th Cong., 1st sess., H. Doc. 1038); Geological Survey Bulletins 600, 621-B, 621-N, 621-O, 623, 629, 631, 640-J, 641-B, 641-D, 641-E 641-F, 641-J, 642-A, 642-B, 642-H, 651, 656, 657, 660-A, 660-C, 661-A, 661-C, 661-D, 661-F, 663; Professional Papers 93, 96, 97, 100-B, 101, 108-H; Water-Supply Papers 380, 395, 396, 400-E, 415, 417, 418, 419, 420, 421, 423, 424, 425-A; Mineral Resources, 1915 (chapters on coke, coal, and copper). In addition, the following separate illustrations were printed and delivered to the Government Printing Office: Diagrams of two bird reservations, one elk reservation, one reservation for the use of natives of Alaska, one reservation for wireless-telegraph station, and two national monuments; maps of six national parks; for the Department of Agriculture outline maps of the United States by counties, relief maps of the United States, maps of the United States and North America (charts), map of the United States showing annual precipitation, map of India, and tick eradication map; for the Department of Commerce, candle-power scale and record sheet; for the General Land Office, protractor charts and folios of the Nenana coal fields, Alaska; for the Forest Service, fire-lookout protractor.

The following work was done for other bureaus and departments: For the General Land Office, 1,194 township plats, 579 mineral plats, 13 State maps showing homesteads, plats of 6 town sites, map of Fort Assinniboine Military Reservation, and other miscellaneous work; for the Office of Indian Affairs, 158 plats of Indian reservations, maps of 6 Indian reservations, plats of 2 town sites, certificates for Indian schools, and other miscellaneous work; for the National Park Service, 7 automobile guide maps, map showing national parks and monuments, administrative map of Rocky Mountain National Park, and other miscellaneous work; for the Forest Service, maps of 25 national forests, 15 recreation maps and fire folders, 2 atlas folios, 4 administrative maps, 9 proclamation diagrams of national forests, 1 game-reserve map, allotment-estimate forms, grazing-data chart, homestead-entry plat, map showing standing timber in the United States, index map, organization chart, and other miscellaneous work; for the War Department, 88 sheets of the Carta de la República Mexicana, map of Belgium, map of Island of Oahu, 5 Geological Survey topographic maps, map of Plattsburg training camp, and other miscellaneous work; for the Navy Department, 330 hydrographic charts and 576 British Admiralty charts.

Work was also done for the Interstate Commerce Commission, Bureau of Standards, Bureau of Mines, Reclamation Service, Bureau of Lighthouses, International Boundary Commissions, Department of Agriculture, States Relations Service, District of Columbia public schools, Weather Bureau, Eight-Hour Commission, Coast and Geodetic Survey, Chief of Engineers, United States Army, Department of Commerce, Office of Public Roads and Rural Engineering, and the commandant, Fort Myer, Va. This work for various branches of the Government amounted to about $97,000, for which the appropriation for engraving and printing geologic maps was reimbursed by transfer of credit on the books of the United States Treasury.

Work was also done for the University of Missouri; Rider Press, New York, N. Y.; Eckert Lithographing Co., Washington, D. C.; International Committee of Young Men's Christian Associations;

Edward T. Millar Co., Columbus, Ohio; University of Idaho; State of Wyoming; Everett Press, Boston, Mass.; Atchison, Topeka & Santa Fe Railway System; International Joint Commission; and John Wiley & Sons, New York, N. Y.; and the money received in payment for the work, amounting to $553.65, was turned into the Treasury of the United States, to be credited to miscellaneous receipts. On requisition of the Government Printing Office, 218 transfer impressions were made and shipped to contracting printers. Under cooperative agreements transfer impressions were furnished without charge to the State surveys of New York, West Virginia, Illinois, and Massachusetts.

Of contract and miscellaneous printing of all kinds the total number of copies delivered was 3,338,028, which required 9,805,217 printings. The total number of copies printed, including topographic maps and geologic folios, was 4,141,425, requiring 14,283,845 impressions.

The sales of maps and folios itemized on page 159, together with $553.65 of other miscellaneous receipts for map work, aggregated $35,889.79, so that more than one-fourth of the amount appropriated for engraving and printing the Survey maps was returned to the Treasury.

PHOTOGRAPHIC LABORATORY.

The output of the photographic laboratory consisted of 18,255 negatives, of which 3,517 were wet, 2,477 dry, 1,351 paper, 7,959 field negatives developed, 621 lantern slides, and 2,330 were made for photolithographs; 4,435 zinc plates; 357 zinc etchings; 355 celluloids; and 45,910 prints, of which 23,666 were maps and diagrams and 22,244 were photographs for illustrations. In addition 1,766 prints were mounted and 42 lantern slides were colored.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

Mails and files.—During the year 273,308 letters were received, an increase of 7 per cent compared with 1916. Of these letters 26,909 contained $36,753.88 remitted for Survey publications, an increase of 14 per cent in number of letters and of $4,740.96 in amount compared with 1916.

The total letter mail sent out from the Survey numbered 566,330, an increase of 30 per cent over 1916. The recording, referring, filing, and mailing of correspondence required the services of nine clerks.

Personnel records.—The roll of Secretary's appointees numbered 934 at the end of the fiscal year, 62 more than at the end of 1916. The total number of changes in the personnel was 904, which included 294 appointments, 234 separations, 339 promotions, 2 demotions, and miscellaneous changes.

During the year 13,762 days of annual and 2,677 of sick leave were granted, being 59 per cent of the amount of annual leave and less than 9 per cent of the amount of sick leave permissible to grant under the law; 4,030 days of leave without pay were also granted.

DIVISION OF ACCOUNTS.

A condensed statement covering the financial transactions of the fiscal year is given below, including disbursements up to August 1 The unexpended balances of that date largely represent outstanding obligations.

Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1917.[a]

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balan
Salaries, office of Director	$35,340.00	$2.67	$35,342.67	$34,434.66	$908.0
Salaries, scientific assistants	29,900.00		29,900.00	29,482.73	417.2
Skilled laborers, etc	20,000.00		20,000.00	19,969.49	30.5
Gaging streams, etc	150,000.00	36,788.93	186,788.93	186,667.39	121.5
Chemical and physical researches	40,000.00		40,000.00	38,497.42	1,502.5
Preparation of illustrations	18,280.00	72.70	18,352.70	18,196.87	155.8
Mineral resources of United States	75,000.00	15.79	75,015.79	73,265.09	1,750.7
Geologic maps of United States	110,000.00	97,176.48	207,176.48	194,229.88	12,946.6
Books for the library	2,000.00		2,000.00	1,708.91	291.0
Topographic surveys	350,000.00	104,373.37	454,373.37	443,598.35	10,775.0
Geologic surveys	350,000.00	9,666.90	359,666.90	351,531.73	8,135.1
Mineral resources of Alaska	100,000.00	492.48	100,492.48	93,047.41	7,445.0
Surveying national forests	75,000.00	15.30	75,015.30	74,922.97	92.3
	1,355,520.00	248,604.62	1,604,124.62	1,559,552.90	44,571.7

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[a] In addition to these appropriations amounts aggregating $215,000, for Survey publications and for ren of the building occupied by the Survey, were allotted from other appropriations but not disbursed by Survey officials.

Classification of expenditures by the United States Geological Survey

Appropriation.	Total.	Salaries and wages.	Transportation of persons.	Transportation of things.	Subsistence and support of persons.	Subsistence and care of animals.	Communication service.	Printing, engraving, lithographing, etc.	Advertising and publication of notices.	Furnishing heat, light, power, etc.	Special and miscellaneous service.	Materials.	Stationery drafting, etc., supplies.
Salaries, office of the Director	$34,433.66	$34,433.66											
Salaries, scientific assistants	29,482.73	29,482.73											
Skilled laborers, etc	19,969.49	19,969.49											
Gaging streams, etc	186,667.39	140,447.76	$14,907.91	$1,080.32	$9,805.48	$114.42	$781.41	$588.98		$8.40	$2,147.39	$3,200.49	$2,312.16
Chemical and physical researches	38,497.42	27,884.05	283.54	428.98	1,836.86	187.26	84.14	8.85		322.39	326.30	2,018.09	352.63
Preparation of illustrations	18,196.87	17,121.01		.62			.30	659.45			1.42	174.93	55.04
Mineral resources of U. S	73,265.09	67,933.69	1,500.49	83.00	1,413.19		583.56	103.04			448.20	.34	873.83
Geologic maps of U. S	194,229.88	136,010.81	104.74	26.55	52.20		84.73	3,634.36		2,014.32	1,557.77	4,325.37	42,509.01
Books for the library	1,708.91			2.42			.10						47.60
Topographic surveys	443,598.35	278,616.81	40,588.36	2,972.28	75,958.05	10,119.24	1,141.30	5,665.78			1,296.54	2,264.59	1,917.14
Geologic surveys	351,531.73	304,217.52	14,845.59	892.01	13,644.42	3,919.71	580.75	4,422.75	$0.60		2,151.71	186.83	1,549.28
Mineral resources of Alaska	93,047.41	60,916.92	13,344.91	2,613.79	4,388.41	105.94	118.37	1,305.89			583.95	419.46	468.58
Surveying national forest	74,923.97	48,125.75	3,538.72	556.79	11,309.45	5,755.31	79.56	123.08			219.47	367.90	304.65
	1,559,552.90	1,165,160.20	89,114.26	8,655.76	118,408.06	20,201.88	3,454.22	16,512.18	.60	2,345.11	8,732.75	12,948.00	50,389.91

Appropriation.	Fuel.	Mechanic's, engineer's, etc., supplies.	Cleaning and toilet supplies.	Wearing apparel.	Forage and other supplies for animals.	Provisions.	Ammunition and explosives.	Special and miscellaneous supplies.	Equipment (including live stock).	Structures (bench marks).	Rent.	Maintenance, operation, and repair of passenger-carrying vehicles.	Purchase of passenger-carrying vehicles.
Salaries, office of the Director													
Salaries, scientific assistants													
Skilled laborers, etc													
Gaging streams, etc	$255.15	$187.96	$7.89	$112.91	$10.75	$47.00	$20.38	$52.67	$7,878.09		$1,202.25	$1,247.62	$260.00
Chemical and physical researches	730.11	54.67					5.39	37.25	3,821.21			115.71	
Preparation of illustrations									184.10				
Mineral resources of U. S		.63	1.59					.10	323.43				
Geologic maps of U. S	83.62	256.74	3.96	31.00					3,535.70				
Books for the library									1,658.79				
Topographic surveys	1,392.50	158.55	75.75	300.79	6,210.61	897.30	2.20	233.50	5,032.42	$2,548.50	87.00	2,504.79	3,624.35
Geologic surveys	106.04	33.32	18.25	44.40	687.94	1,545.70	1.35	116.41	1,582.01			985.14	
Mineral resources of Alaska	794.91	98.85	44.16	187.24	104.16	3,219.29	39.84	27.74	4,211.00		54.00		
Surveying national forests	96.41	9.57	12.67	8.20	2,443.25	97.25		22.91	1,678.76		28.52	145.75	
	3,458.74	800.29	164.27	684.54	9,456.71	5,806.54	69.16	490.58	29,905.51	2,548.50	1,371.77	4,999.01	3,874.35

LIBRARY.

During the year the library received 9,352 books, pamphlets, and periodicals and 438 maps, a total of 9,790 publications. Current accessions were catalogued as received. Titles sent to the Library of Congress for printing numbered 589; letters received, 3,768; letters written, 1,926; books collated and bound, 1,625. The loans during the year included 5,961 books and 287 maps. This number does not include books consulted in the library by 7,491 readers.

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